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Engineering News-Record

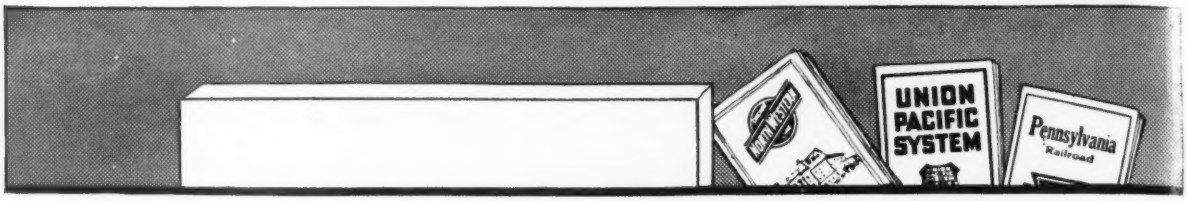
Tower, 265 Ft. High, Tops 24-Story Building
Along Chicago's Double-Deck Wacker Drive

De Berard on Mississippi River Flood Regions—*First Article*

Sewage Settling Tank Design, by C. H. Capen, Jr.

Concrete Form Handling for Covered Reservoirs, Providence, R. I.

New England Flood Conditions



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ENGINEERING NEWS-RECORD

DEVOTED TO CIVIL ENGINEERING AND CONTRACTING

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Vermont's Flood Situation

FIGURES compiled since last week's issue went to press show more definitely how great were New England's flood losses. The upper land western parts of Vermont, where the storm centered, suffered heavily. A report in this issue by John W. Shaver, who worked his way through many of the flooded valleys on a tour of observation for *Engineering News-Record,* outlines the situation comprehensively. Surveys by local authorities, compiled by Secretary Hoover, place the total losses in Vermont alone at $30,000,000, or $75 per inhabitant, or $300 per household; and probably half of this will fall directly on the people—that is, all of the domestic loss, most of the highway damage, and a smaller part of the industrial damage. Fortunately the facts of the flood show that similar destruction need never be repeated. There will be future storms of equal violence, just as similar storms occurred in the past—58 years ago, and again 30 years ago, these having been if anything somewhat greater than the present one, as shown by the remarkable rainfall study of Prof. H. K. Barrows which we published last week. The 1927 flood possibly was more intense at a few local points; but in the main the unprecedented severity of destruction is attributable to neglected runoff conditions, including constricted channels—as at Montpelier—and primitive dams which were allowed to remain. The absence of all supervision over stream channels and dams on the part of the state is a responsible factor in the situation. As the topography of the region is favorable for the construction of detention works, there should be no difficulty in providing a substantial measure of stream control at reasonable cost. Of course it would be necessary for the local communities as well as the state to join in the work. But in view of the state-wide extent of the flood destruction the primary initative rests with the state authorities. Assumption by the state of active control over watercourses and dams, and legislation authorizing the formation of flood-control districts, would be the first step toward removing the threat of large-scale flood destruction from Vermont.

Settling Tank Design

SEVERAL decades ago, when sewage treatment in America was just starting, the promoter of a proprietary process remarked that give him a settling tank long enough he would ask for nothing else in the way of plant. Like Archimedes with his lever, this modern with his new problem did not venture to say how long his tank would need to be. About the same time an engineer of a more scientific turn of mind ventured to write a paper on the theory of water sedimentation. Since then rule of thumb methods in the design of settling tanks for both water and sewage have been followed to a remarkable extent, so far as the physics of sedimentation has been concerned. Engineers in both fields, we feel sure, will therefore give close attention to the paper on sewage settling tank design elsewhere in this issue. The author was prompted to study his subject by his duty as a state sanitary engineer engaged in promoting the efficient operation of sewage-works. These led him from observation to experiment and to a search of the studies of others. All this is summarized in his article, which closes with a few clear, cut conclusions readily grasped by the too-common untrained as well as by the trained operator and the designing engineer.

A Courtesy Due

CONGRESS at its coming session has an obligation as well as an act of courtesy to perform by extending an invitation to the International Association of Road Congresses to hold its next conference, which comes in 1930, in the United States. The executive committee of the association meeting in Paris this year, following the Milan conference of 1926 in which American delegates first took an official part, has voted to defer decision on the next place of meeting until Congress has had opportunity to say whether an official invitation will be extended by the United States. Recognition of this deference is the act of courtesy required. The obligation to invite the next conference to the United States comes from the change in status of this country in the rank of road building nations. It is now a leader and not a follower in highway construction and upkeep. With this new rank there is an obligation to help, and there are many reasons why help can be given and many people who are keenly searching for it. In the year drawing to a close, highway officials from 15 nations, delegated to study American roadbuilding practices, have spent time with state and federal highway officials gaining such knowledge as would help them. And the wide variations to be found here in climate, topography, traffic, population density, soils and materials, offering somewhere conditions closely parallel to and problems quite typical of their own countries, have seldom allowed an inquirer to depart empty handed. At the Milan conference last year there were highway officials from 52 countries and it is reasonably certain that as many would be represented at an American conference in 1930. Congress delayed long in placing the name of the United States on the official roster of the international association; it will be necessary for those in the highway industries to make sure that the same dilatory tactics do not prevent the 1930 conference of the International Association of Road Congresses from being held in the United States.

Responsibility at Crossings

A BRIEF decision of the United States Supreme Court in an unimportant grade-crossing accident case bids fair to change the whole status of the grade-crossing problem. The court, in fixing responsibility as between the railroad and the man on the highway, attempted to

"lay down once and for all" a standard of conduct for the latter. According to this the road user bears the entire responsibility, unless he has taken every precaution, even to getting out of his vehicle to obtain a clear view. The decision was given in full in our news pages of Nov. 10. The matter is too complex to permit of an extended review of its possibilities in the short space of time which has elapsed since the decision was rendered, but there are certain features which stand out. The decision appears to shift responsibility for grade-crossing accidents at unguarded crossings from the railroad company—where it usually has been placed—to the man on the highway, a natural cause for rejoicing on the part of the railroads. But the shift automatically places greater responsibility upon the railroads and the public utility commissions for seeing that the highway traveler has every advantage in the way of unobstructed view and proper grades. Also, it will increase the demand for more rapid elimination of grade crossings. Consequently, though the railroads may be relieved of much of the indemnity burden which they now bear they may find that the saving is more than offset by added expenditures for such work. If so, the money will be diverted into more productive channels.

A Gasholder Explosion

PITTSBURGH'S tremendous gasholder explosion last week remains without explanation so far. It is an occurrence that demands the most searching investigation, and ultimately a complete and satisfying explanation. Gas plant and holders look back upon a rather remarkable record of safety; accidents which involved explosion of the gas have happened only at rare intervals. And people have accordingly been content to live and work near gasholders without thinking of the great accumulations of combustible gas as a danger. But when we see how an entire city district is devastated and hundreds of persons are maimed by such an accident as that at Pittsburgh, it is not altogether comforting to know that it happens only rarely; to those who live in the shadow of the holder the risk is bound to be ever-present. It is therefore vital to know whether this explosion was due to palpable neglect or whether it resulted from a more or less unpreventable chain of happen-sos. Risks—even great risks—that are controllable by foresight may be tolerated, just as we tolerate the operation of hundreds of high-pressure steam boilers in densely populated city regions. But those risks which are unforeseeable and unpreventable are direct threats to the security of existence. By coincidence, within a few days of the Pittsburgh explosion, in which welding equipment and a supposedly empty gas tank figured, a steamship in process of being dismantled at Baltimore was wrecked by an explosion which involved cutting torches and an empty oil tank. The combination of flame or arc with "empty" tanks of gas or oil seems clearly dangerous. It has long been considered bad practice to play with matches in a powder magazine; and similarly it may be found, after the Pittsburgh explosion is investigated, that rules of caution relating to gasholders in cities can be set up which will eliminate the chance of such a terrible accident being repeated. Here again, however, clearing up the present explosion is the first necessity. It is the obligation not only of the community concerned but equally so of the gas industry itself.

Control of Water Power Development

LACK of uniformity in state laws relating to the control of water power and a wide divergence in such laws in most states from the requirements of the federal water power act have resulted in a chaotic condition which should be remedied if we are to get the most out of our water power possibilities. Most states attempt to exercise control over water-power developments within their borders but in some the laws are so drastic as to hinder development while in others they are too lax or are ineffective in preventing irregularities in financing or waste in such matters as construction costs. In very few instances do states attempt to insure the full economic development of all the power sites on their streams, as does the Federal Power Commission on streams which come under its jurisdiction. Then too, the jurisdiction of the federal commission is so indefinite as to result in controversy over who shall take jurisdiction.

The Federal Power Commission, in its annual report to Congress, draws attention to this state of affairs and recommends that state laws be so modified as to make it possible for the states to co-operate with the commission in the exercise of control. Just how such changes can be brought about or how they will improve matters in so far as conflict with the Federal Power Commission is concerned is not made clear in the report. If laws embodying all the essential features of the federal water power act were to be written upon the statute books of all the states then, of course, the federal commission could safely pass on to the states the financial and accounting supervision of power developments within their several borders. The commission intimates in its report that this should be done. But such a condition is impossible of attainment with the different views in regard to public utility control which are held in our several states. A surer way of eliminating much of the present conflict between the states and the federal commission would be to define the jurisdiction of the Federal Power Commission much more clearly, removing from its control power sites on streams of doubtful navigability and limiting its authority to the really navigable rivers, to international streams and to interstate streams where control cannot be exercised effectively by the adjoining states, also specifying the taxing powers of the states over developments built under federal license.

Such a plan would not eliminate all of the present bad conditions, especially the practice of locating power plants with an eye to cheap developments of the site rather than the best development of the entire stream; in fact it may make this practice more common for a time, as the Federal Power Commission is the chief opponent of such procedure. However, with the survey of the water and power resources of our streams which has been proposed to Congress likely to be undertaken in the near future that situation is in a fair way to be remedied. Such a survey must, of necessity, set up a tentative program of power development for each stream and no state would be so short-sighted as to permit power developments which were not co-ordinated with such a plan once it was promulgated. Any immediate change in the laws of many of our states in order to make them conform to the federal power act is almost out of the question, but there is no reason why the federal law cannot be modified to eliminate at least a part of the present trouble. A definite recommendation from the commission on this subject would be of value.

Reclaiming the Valley

IN A series of articles on the Mississippi River flood area which is begun in the present issue, *Engineering News-Record* will undertake to present by eye-witness account a description of the famous basin lands and their people, and what their reclamation from flood means. No one can think constructively of the Mississippi problem without first having a concrete understanding of its factors, not only the hydraulics but also the topography, customs and economics of the valley bottoms. He must know what the construction and maintenance of the levees mean before he can judge of future possibilities in river control; and he must know also the peculiarities of the prevailing tenant farming system and its earnings or losses before he can side with either those who want the basins kept forever dry or those who advocate controlled submergence. Our articles will attempt to give this essential information, to supply a basis on which constructive views may be built up among the body of the engineering profession, and thereby among the general public. For the problem in hand is of such magnitude that no method of dealing with it is likely to prevail that is not supported by the general approval of the people.

That critical engineering questions are at issue is well known. It was more specially evident at the recent Columbus meeting of the American Society of Civil Engineers, where, after representatives of the Mississippi River Commission had recounted the history of bank-protection work along the river, sharp attacks were made against them for their alleged failure to study detention-reservoir possibilities before now, and various special expedients were advocated for the control of the river. Spillways, supplementary outlets and side channels were argued; even forestation brought out an official defender. It is true that the more fantastic panaceas that found their way into print during the past year did not come before the meeting, but even without them, it was plain, there is wide divergence of engineering thought on the subject.

Nevertheless we believe firmly that when the essential facts about the Valley come to be fairly understood throughout the engineering profession, conclusions will progressively crystallize, and the various proposed solutions will take rank in accordance with their true worth. Isms and special pleadings are not likely to stand up long against a widely disseminated stock of sound knowledge.

Much talk has been made on the theme of Levees Only, and accordingly a belief has come to exist that first of all a choice must be made between levees and something else—reservoirs, perhaps, or parallel channels—before anything can be done to control the river. Fortunately this is not the case. The demands of the present are plain: to repair the breached levees, to proceed as rapidly as possible with completion of the levee line to full height and strength, thereby making the basins safe for all floods except possibly so extraordinary a one as that of the past spring; and meantime to carry on energetically, but with the leisure of scrupulous care, the study of auxiliary safeguards.

Work has been in progress for months along this line. It is now important that everybody should realize the necessity for patient study of flood conditions and their relation to relief methods *before* any further type of work is taken in hand. To put it another way, we must not expect that Congress can solve the problem of the Mississippi by legislative fiat, or that the clamor of this or that interested group can establish the right course of action. Only the results of elaborate study, interpreted with hard common sense, are capable of furnishing the ultimate answer.

The difficulty is the greater because not only the Mississippi and its bottom lands are involved but many tributaries with their drainage areas, for hundreds of miles back from the main river. The flood problems of the Arkansas, the White and the Red rivers form an integral part of the Mississippi problem. Where to draw a limiting line, in ascending these tributary streams, and say that here the national responsibility toward the Mississippi ends and local responsibility toward the tributary floods begins is one (and not the least) of the troublesome difficulties of the case.

Even on the main river, while the substantial proposals for auxiliary relief are few in number, they constitute each a major problem of its own. Reservoiring the main river may be left out of consideration as it has not been seriously proposed, we believe. Partial detention of basin runoff in the basin areas themselves; use of the basins for flood lowering by controlled submergence through flood gates; side channels; and the Atchafalaya outlet: these are the principal expedients offered for the main course of the river, and discharge spillways at one or two selected points for the extreme lower course. None of these is susceptible of offhand judgment, but acceptance or rejection can be based only on thorough analysis and research. That of necessity is work requiring long continued effort.

On the physical side, therefore, the Congress soon to assemble has no very difficult question to decide. It cannot do less than authorize and support a very substantial levee program; it cannot usefully do more, except to direct the necessary thorough studies and provide the money therefor. Much good will result if this simple fact is clearly understood by all taxpayers and public-spirited citizens.

There is also the financial side of the case, and this is of much more immediate difficulty. The question is whether the cost of laying dry and keeping dry the basins of the Mississippi, its natural flood bottoms, shall be borne wholly by the country at large, or shall be laid as a tax on the land benefited. It is not an easy one to answer.

When we are told that the population which was flooded out is virtually bankrupt, we recognize that it is proper to extend them temporary aid to tide them over their present distress. But when we are told that the value of the land will not warrant the tax burdens necessary to protect it—or even to pay half or one-third the cost of protection—we are likely to ask, why protect it? Of course, this mere question does not dispose of the matter; nor, on the other hand, does an eloquent resolution that speaks of national responsibility and asserts that the whole Mississippi control should be met from the federal treasury. The matter is more intricate than either statement assumes.

The financial problem will face Congress at the outset, and must be solved. It depends not only on broad principles of policy, but also on the conditions that exist in the flood areas. Since much of the information which our series of articles will bring out bears on these conditions, we hope that the series will help in building up views favoring a sound policy. But any fuller discussion of the financial problem of the Mississippi must wait for another occasion.

Tower 256 Ft. High Tops 24-Story Building

Steel Building Has Columns Anchored Against Uplift—Special Framing Carries Offset Columns—Wind Bracing—Concrete Floors—Erection Plant

A SLENDER 18-story tower 256 ft. high surmounting a 24-story office building 265 ft. high is a conspicuous feature in the architectural designs of the Mather Building, Chicago, and imposed several difficulties upon the structural design. The heights given are above the upper deck of Wacker Drive, which is some 32½ ft. above the river level or Chicago datum, the total height from water level to summit of tower being

FIG. 1—MATHER BUILDING AND TOWER, CHICAGO
London Guarantee Co. Building at left. Bell Building at right.

553½ ft. This tower is made the more conspicuous by having its walls of gleaming white terra-cotta with elaborate decorative treatment. In the main part of the building the curtain wall of the street front is of light gray brick and terra-cotta. A view of the structure with tower framing completed is shown in Fig. 1.

The main portion of the building is about 65x100 ft. in plan at the street level, reduced by rear offsets at the 9th and 16th floors to 65x85 ft. at the 24th floor. The octagonal tower, set back a little from the narrow front, has a diameter of 41 ft. 10 in. for its lower portion, then reduces by successive offsets to a diameter of 21 ft. 10 in. at the 42nd floor; above this it is further reduced to 9 ft. 6 in. in diameter at the lantern.

Foundations—Concrete piers built in open wells are carried down to solid rock at about 108 ft. below river level. As the piers on the two longer sides have their outer edges at the property lines, cantilever girders supported on pairs of piers are required to carry wall columns located at the property lines and therefore eccentrically to the piers. Each cantilever consists of two or three parallel plate girders connected by diaphragms and seated on I-beam grillages in the tops of the piers, the concrete being reinforced by hoops and vertical rods to a depth of 4 ft. Some of these girders are about 28 ft. long and 4½ to 5 deep, on piers 22 ft. c. to c. and carrying columns 23 ft. 6½ in. c. to c. One of the shorter cantilevers, with column framed between the two girders, is shown in Fig. 2. All the girders are encased with concrete. Similar reinforcement and grillages are used at piers which carry columns directly.

Uplift Anchorage—Owing to the height and comparatively small horizontal area of the building, a definite uplift may be developed by certain wind conditions. For this reason, there is introduced the unusual feature of anchoring the four corner columns deeply into the piers, instead of using the ordinary anchor bolts which simply hold the column shoes in position.

All these anchored columns are supported by canti-

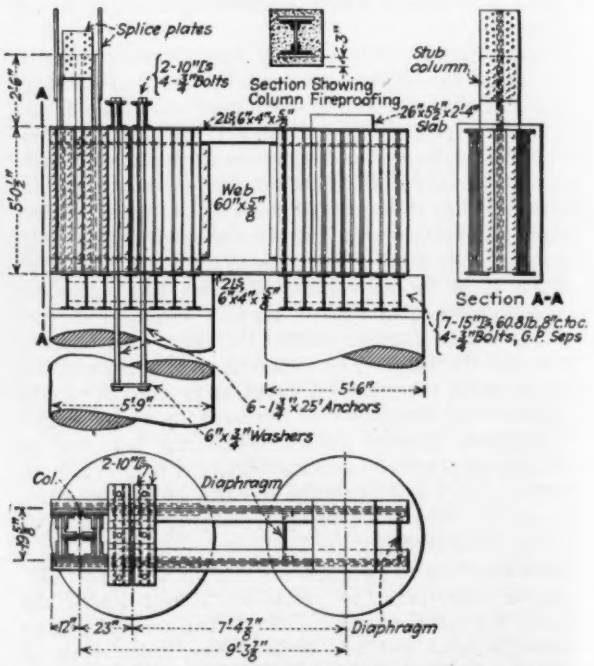


FIG. 2—FOUNDATION CANTILEVER
Note anchorage against uplift; for corner columns only.

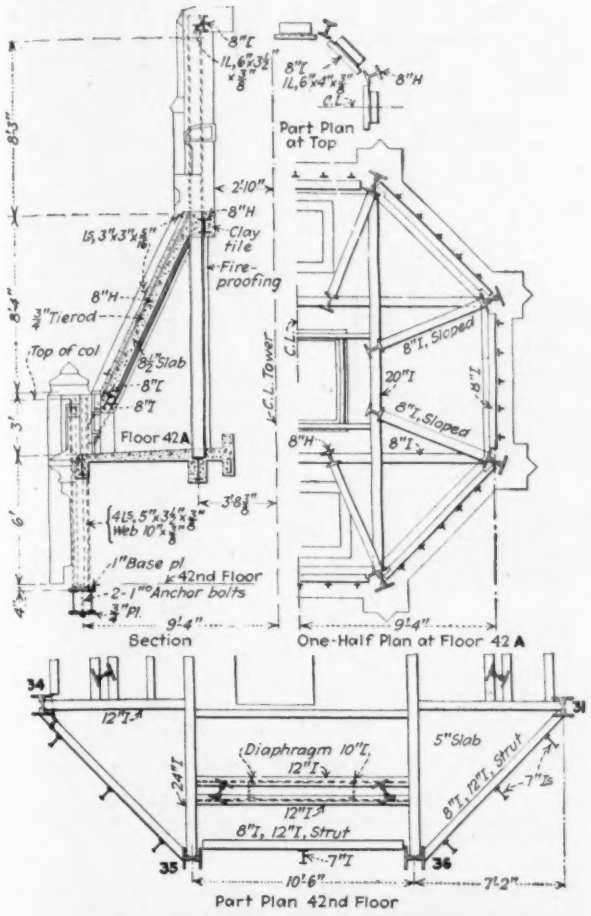


FIG. 3—FRAMING AT TOP OF TOWER

levers, and instead of simply being seated upon top of the cantilever they are carried down between the two parallel girders and connected to them so as to form an L-shaped unit structure (see Fig. 2). Just back of the column are two pairs of channels laid across the girders and having washer plates on which rest the heads of six 1¼-in. anchor bolts 25 ft. long. These bolts, embedded in the concrete, carry large washers or anchor plates at their lower ends.

Columns—All main columns are of H-section, built up of a web plate, four angles and two cover plates. The largest sections have the web composed of two plates 14x⅝ in, with angles 8x6x¾ in., and 18-in. cover plates on both sides, each aggregating 3⅛ in. in thickness. They are seated on cast-steel bases or rolled-steel slabs, except for the corner columns. The latter are framed between the pairs of plate girders forming the foundation cantilevers, with four connection angles attaching the column to the two girder webs. All columns are fireproofed with concrete, giving a minimum thickness of 3 in. over the steel. This is shown in Fig. 2, while another drawing shows one of the four corner columns with concrete fireproofing, brick wall and terra-cotta facing.

Four columns extend in unbroken line from the foundation girders to the 41st floor and form the core of the tower framing. These are columns 28, 29, 32 and 33, which may be identified on the accompanying drawings of floor framing at various levels. Eight adjacent columns extend to the 36th floor, and are then set back, being supported on girders in the floor framing and extending to the 41st floor. A little above the 42nd floor level, the tower tapers upward to the lantern. Here the framing is carried on eight columns of 8-in. H-beams with 8-in. I-beams for inclined braces which also serve as rafters for the sloping roof. Above this again the diameter is reduced to 9½ ft. and the framing for the upper portion or lantern consists of eight columns composed of 8-in. H-beams. This construction is shown in Fig. 3.

Floor Framing—In the 24-story portion of the building the typical floor framing consists mainly of heavy I-beams forming rather large panels, but plate girders are used for the spandrels in the front and rear. In Fig. 4 is shown the framing of a typical floor and also the special framing at the 24th floor, which is the top of the main building and the base of the 18-story tower. In this 24th floor framing are triple sets of I-beams to support offset columns. The floor framing supports concrete floors of the slab-and-joist type, 12 in. deep, including the 3-in. slab, as shown in Fig. 5. An exception to this is the 24th floor, which has a solid concrete slab 6 in. thick.

A central hall has six elevators in two groups, which extend to the 23rd floor; one of these is a freight elevator. Two of the passenger elevators continue to the 37th floor, above which stairs are provided. The shaft for smoke-stack and ventilating flue has to be offset at two or three levels, but then rises through the center of the tower.

Tower Framing—In the tower, the floor framing is also mainly of I-beams, but girders and pairs of I-beams

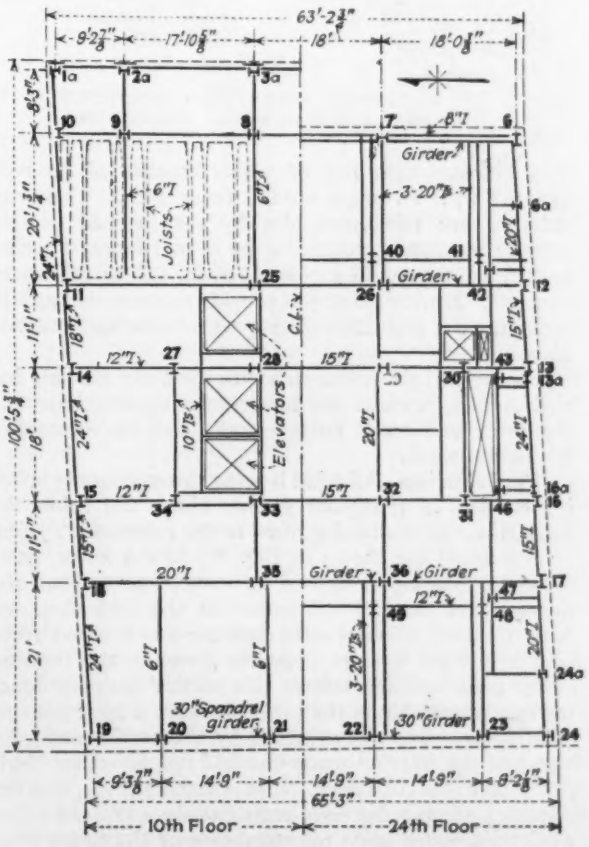


FIG. 4—FLOOR FRAMING IN MAIN BUILDING
The 10th floor is typical. The 24th floor is top of main building and base of tower.

are introduced at the 36th and 39th floors to carry the offset columns. The framing layout of several floors in the tower is shown in Fig. 6. One of the special supports for an offet column at the 39th floor is shown in detail in Fig. 7.

A different arrangement at the 42nd floor is shown in Fig. 3, where the offset columns for the lantern or upper part of the tower are seated on girders composed of pairs of 12-in. I-beams connected by diaphragms of 10-in. channels. At the next floor, a framing of I-beams supports the eight offset columns which extend to the top of the lantern, where they are connected by a line of

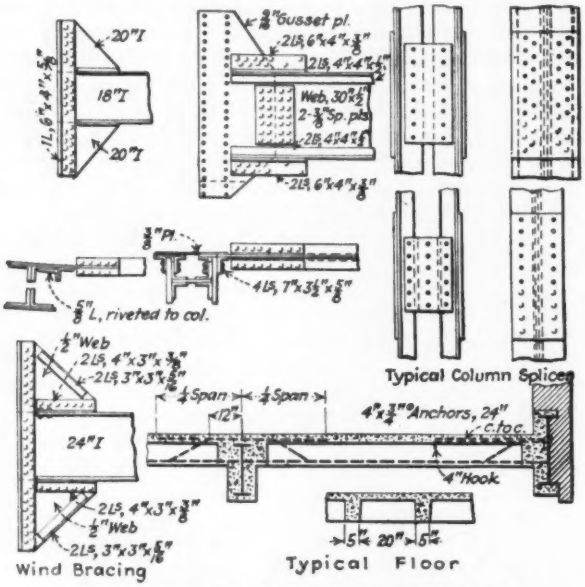


FIG. 5—TYPICAL STRUCTURAL FEATURES
Wind bracing. Column splices. Concrete floor.

ring bracing, each bay of which consists of an 8-in. channel with an angle on the outer face. These top columns are reinforced also by the inclined bracing already mentioned, consisting of 8-in. I-beams attached to stub columns and cased in an 8½-in. slab of reinforced concrete. Horizontal angles provide supports and attachment for the decorative facing on this inclined concrete slab.

Throughout the entire structure the outer framing has shelf angles, brackets and hangers for the attachment of the brick and stone curtain walls and the decorative terra-cotta work.

Wind Bracing—All wind bracing throughout the building consists of triangular gussets above and below the connections of spandrel girders to the columns. Typical arrangements are shown in Fig. 5. In the tower, however, this bracing is applied at connections to both the interior and exterior columns. At the 24th floor, or base of tower, a heavy solid concrete slab is provided to distribute wind stresses from the tower to the framing of the main building below. No vertical diagonal bracing was practicable in the tower, because a large amount of window space was provided by the architectural design and the interior space was laid out for office occupancy up to the 37th floor. It is stated, however, that the workmen placing the terra-cotta curtain walls and other work commented upon the steadiness of the tower even during high winds.

Erection Methods—For the steel erection, a guyed

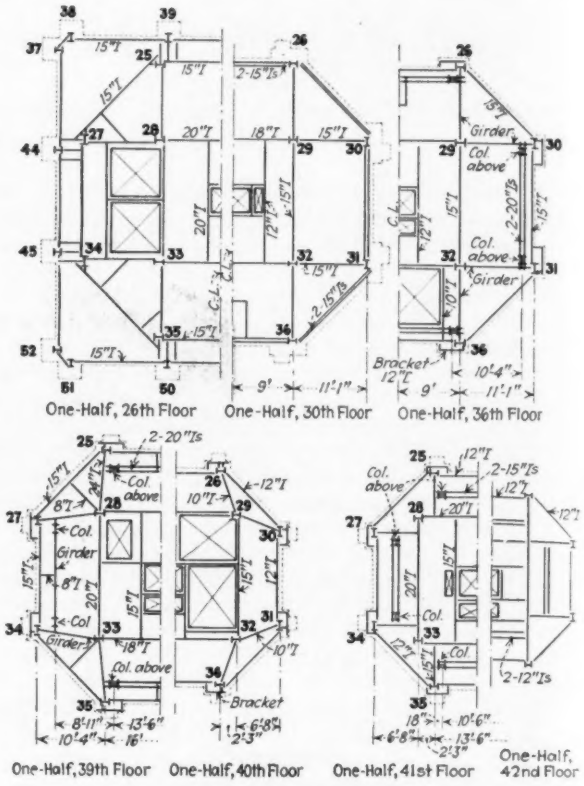


FIG. 6—FLOOR FRAMING IN TOWER
Showing girders and supports for offset coflumns at different levels.

derrick with 100-ft. boom and 110-ft. mast was used on the main building, up to the 24th floor. A stiff-leg derrick with a 60-ft. boom was then placed on this floor and hoisted the tower material up to this level, above which the erection was continued with a small guyed derrick having a 40-ft. boom and 50-ft. mast. The columns were delivered in two-story lengths, but all the tower framing was light material.

Masonry materials were handled in a single shaft which extended from the sub-basement to the top of the tower. This shaft ran inside of the building up to the

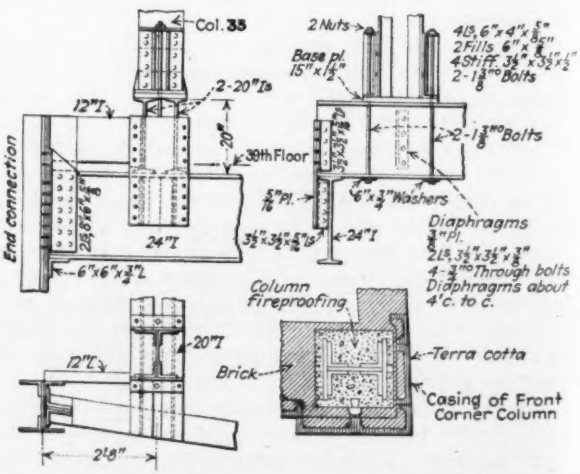
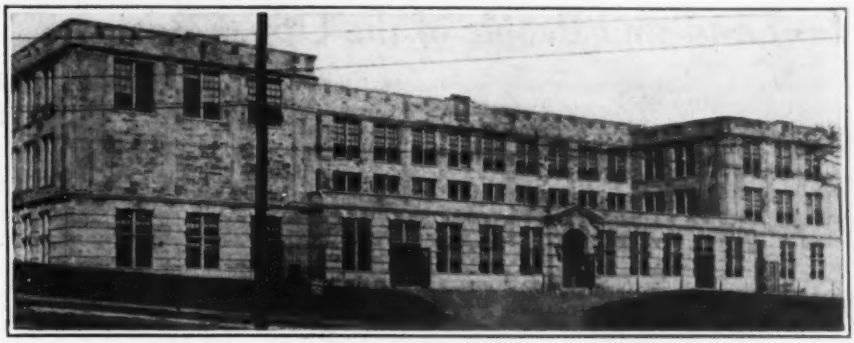


FIG. 7—SUPPORTS FOR OFFSET COLUMNS
Arrangement at 39th floor. Also fireproofing and casing of corner column.

24th floor, and then continued on the outside to the top of the tower in the form of a temporary wooden hoisting tower. This shaft carried a 1-yd. concrete bucket which dumped at various floors for all concrete fireproofing, up to the top of the tower. The material bins and mixer were located in the basement and the mixer discharged directly into the bucket.

After the concrete fireproofing was completed, the bucket was removed from the shaft and a single-cage platform hoist was installed, the cage being large enough to accommodate two concrete buggies or four wheelbarrows. Both the concrete bucket and the material platform were operated by a high-speed 90-hp. hoist, located in the basement. In addition to this equipment, there was an ordinary double-cage hoist in one of the elevator shafts, which operated from the basement to the 24th floor. There was no rehandling of materials at the 24th floor, except for a very small amount of material used in finishing up some of the tower work when the main hoisting shaft was removed.

Designers and Builders—For this building, Herbert H. Riddle was the architect; and Lieberman & Hein were the structural engineers. The general contractor was W. A. Illsley, with R. F. Wilson & Co. as masonry contractors, while the steel erection was done by the Overland Construction Co.



ENGINEERING HALL, UNIVERSITY OF ARKANSAS

New Engineering Hall at the University of Arkansas

Three-Story Concrete Building Houses College of Engineering and Experiment Station at Fayetteville

IN THE gradual development of facilities at the University of Arkansas, Fayetteville, Ark., two new buildings have been completed this year for the College of Engineering and the College of Agriculture. These buildings, provided for by a state appropriation of $650,000 in 1925, which was supplemented by $50,000 from university general funds, were occupied by the respective colleges at the opening of the fall semester in September, 1927.

The new Engineering Hall houses the departments of civil, electrical and mechanical engineering, drawing and architecture, and provides laboratories, drafting rooms and class rooms for these departments, as well as general offices for the college and the engineering experiment station. This building consists of a central portion 130x52 ft., with two wings each 84x42 ft., forming a three-story channel-shaped building with a frontage of 214 ft. The structural design is of reinforced-concrete columns and girders, with concrete floors of the slab and joint type, made with removable metal pan forms. The slab is 2 in. thick. A roof of similar design is covered with composition roofing.

For the upper floors, the design live-loads are: Library, 180 lb. (on account of the book stacks); blueprint room, 100 lb.; auditorium, 80 lb., and class rooms, 50 lb.; roof, 25 lb. per sq.ft. Partitions are of hollow tile, so that they can be moved readily for any future rearrangement of the rooms. The exterior walls are of gray cut limestone, backed with brick in the first story and with hollow tile in the upper stories. Steel trusses carry the roof slab and steel sash is used for the windows. For the stairs and corridors the flooring is of terrazzo, but elsewhere a cement finish is applied to the concrete floor slab. In the library, the slab is recessed ¼ in. for a linoleum cover within the terrazzo border. The interior woodwork is of oak, with walls and partitions plastered, sized and given two coats of washable wall finish in buff or stone color. Light, heat and power are supplied from the university's central power station.

The basement floor is devoted entirely to laboratory use: (1) Civil engineering: cement testing 19x20 ft.; materials testing, 35x33 ft.; bituminous testing, 18x33 ft.; road materials, 20x33 ft.; hydraulic, 27x23 ft. (2) Electrical engineering: standardizing, 29x29 ft.; high tension testing, 40x45 ft.; dynamos, 35x53 ft.; photometric room, 10x23 ft.; battery room, 10x12 ft.; and instrument room, 10x20 ft. (3) Mechanical engineering: mechanical laboratory, 45x80 ft.; tool room, 12x18 ft. (4) General: experiment station laboratory, 28x29 ft.; instrument repair shop, 20x35 ft. To facilitate the handling of machinery and apparatus, a runway for a trolley hoist is suspended from the ceiling of the corridors.

On the second floor is the college library and reading room, with steel book stacks for 13,500 volumes. Here also is the auditorium, which will seat 250 persons. The window shades for darkening this room are operated by two ½-hp. motors controlled from the speaker's stand. In addition, there are six offices, an instrument room for the civil engineering department, and seven class rooms with total seating for 216 students. On the third floor are five drafting rooms 18x42 to 22x52 ft., for the civil, mechanical and electrical engineering departments, and the freshmen and sophomores. There are also offices, a blueprint and photographic room, 16x24 ft., and four class rooms with total seating capacity for 122 students.

The architects for the university and designers of the Engineering Hall are Jamieson & Spearl, St. Louis, Mo., and H. R. Burks, Little Rock, Ark. For this new building W. J. Knight & Co., St. Louis, Mo., were the structural engineers, and the general contractor was the George Fuller Greene Construction Co., Kansas City, Mo.

BEGINNING A SERIES OF ARTICLES :

Today in the Mississippi Flood Area

Engineering and Human Conditions in the Basins and Along the Levees as an Engineer Sees Them

By W. W. DeBerard
Associate Editor, *Engineering News-Record*

I—Land and People of the Upper Basin

INTRODUCTORY NOTE—Conditions in the flood region of the Mississippi River, on which depends the solution of our greatest national problem, are almost unknown except to those who live in the basins. In order to familiarize engineers with these conditions, both physical and human, W. W. DeBerard is traveling through the valley and writing an account of his observations for *Engineering News-Record.*

The present article is the first of his reports. Later articles will deal with the lower basin regions and their flood and after-the-flood experiences, with levee construction and repair, with crevasses and spillways. Mr. DeBerard is studying not only the lay of the land but also the people and their opinions and needs, so that the reader may be able to form his own conclusions as to what protection must be provided, how far the basin areas should protect themselves and what methods they can use.—EDITOR.

SIX MONTHS after the most disastrous flood in the history of the Mississippi Valley, what is the situation? I am spending a month in the Valley to obtain an answer to this question for the readers of *Engineering News-Record.*

It will be recalled by everyone that this year's high water went a foot or two above the highest record in modern times on almost the whole of the thousand-mile distance from Cairo to the Gulf; that levees were breached at a great many points—226, to be exact—with the result of submerging a total of some 20,000 square miles in several states; that about 250 lives were lost, hundreds of thousands were driven from their homes by the rising waters, and crops and livestock were destroyed.

Since the matter of flood control legislation is now so close at hand a mental picture of the valley is desirable, a view of the land as it is. What utilization is made of the land? What are the farm methods, the nature of developments, holdings, real estate operations, values, financing and transportation? How fully has the country recovered? What is the present morale of the inhabitants and their expectancy as to eventual freedom from floods? All of these factors, most of them human, need visualization as a background before the engineering problems of levees, revetments, auxiliary channels, spillways, and the like are taken up.

ASPECTS OF THE UPPER BASIN

So large is the area it has been thought best to take up the various situations more or less geographically beginning, as did my trip, at Cairo and proceeding southward, the first headquarters being Memphis. This city, high on the east-bank bluffs, is a distribution and market place for a large area in all directions. This article was written after 10 days in the field. While not "in" on the last flood, it may not be amiss to say that the writer rode the crest of the 1922 flood, the highest up to that time, to New Orleans, saw the Poydras crevasse near the site of the man-made Caernarvon Cut of this year, and slept for three nights in Arkansas City, where floods have occurred so often that the main street has double-deck sidewalks. The site of the present Mounds Landing crevasse, the greatest in all history, was visited in 1922, when water lapped the first layer of sandbags on top of the levee. For a recounting of those strenuous days, for the Mississippi River Commission repeated in greater measure in 1927, see *Engineering News-Record,* May 18, 1922, p. 814. In that article appears a drawing showing coverage of various previously recorded floods.

Probably few, if any, lands flooded in 1927 have not been flooded in some previous rise but civilization gets more intense, reclamation reaches farther and farther into the low, rich deltas, and in consequence values multiply, making losses with each succeeding inundation that much more severe. Typical of this flooded area, which is virgin timber, cut-over lands or fully reclaimed land, is the region west, southwest and northwest of Memphis, in the St. Francis and Little River valleys.

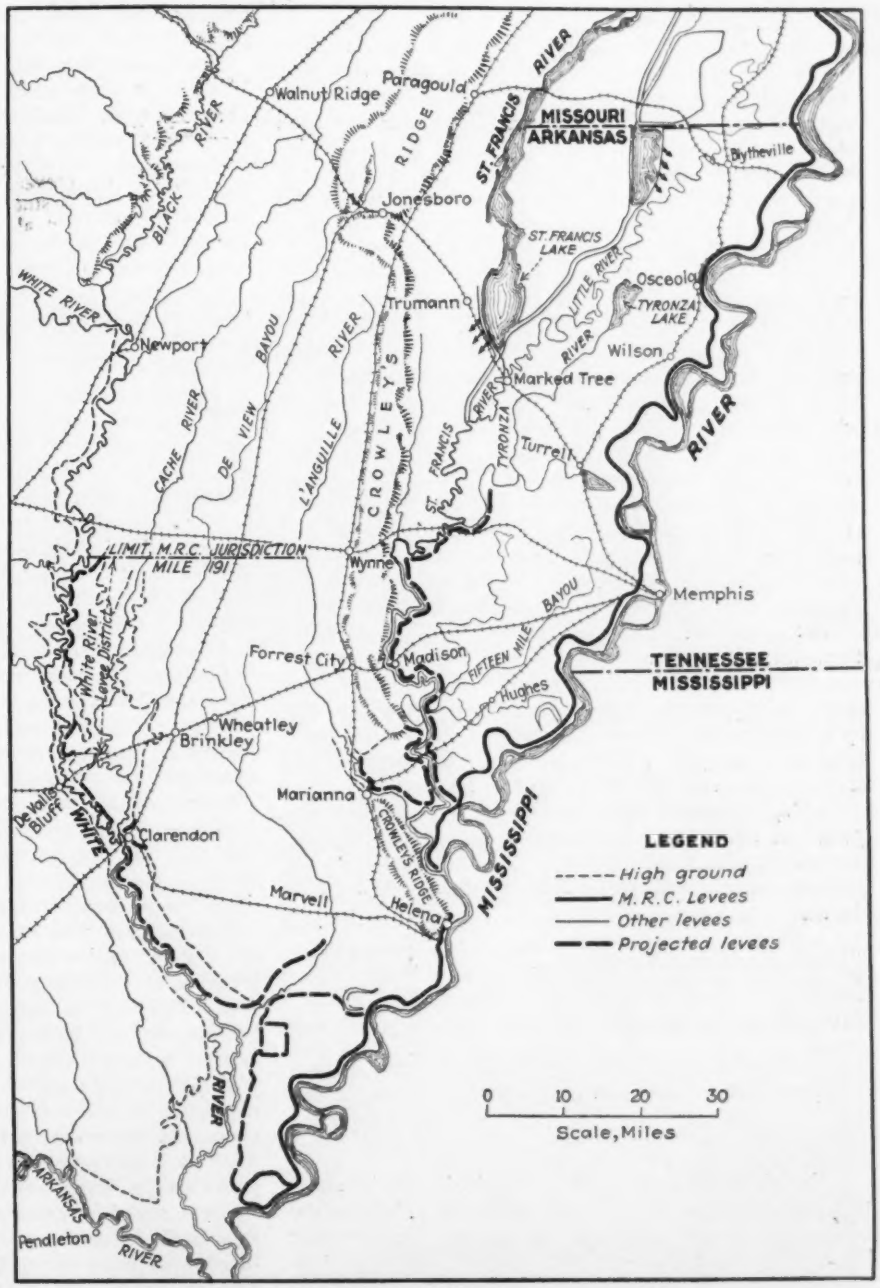
FLOODING OF ST. FRANCIS VALLEY

Paradoxical as it may seem, the main rivers flow along ridges built up by depositions from overflows. Troughs of low land lie between the rivers. Crowleys Ridge has no river, however, being of different geological formation, 200 ft. in height in places. It extends from Helena north into Missouri. On each side of this ridge lie the first north-and-south strips of inundated territory west of the Mississippi, varying from 10 to 30 miles in width, 150 miles long on the St. Francis and Little rivers and 200 miles long on the White.

The initial flooding of this district was due to local rainfall in Missouri and Arkansas. Drainage reclamation in the upper reaches, not always carried through to the discharging points downstream, has made converts of doubting owners in flooded districts opposite Blythville, Osceola and Wilson to the necessity of adequate channel capacity on the lower reaches. This was not a flood caused by breaks in the levees of the Mississippi primarily, except as a comparatively small amount of water from the Dorena crevasse broke over the ridge running north from New Madrid. It prolonged the period when the water lay on the land, but it did not arrive until after the higher floods due to local rainfall had passed. All of this area, however, is behind and below the Mississippi main levee system. Highest-of-record flood heights on the St. Francis, the White and the Arkansas overtopped local protection levees along these tributaries and caused so much damage that the Mississippi River Commission has been requested to take over the levee systems. Repairs have been made in many places.

Accounts of rich delta lands had conveyed to my mind, used to North Central farm conditions, a quite imperfect picture of what this Arkansas country is like. Some of it, on Crowleys Ridge, grows diversified crops, maintains pastures for cattle and is farmed by the owner in fact. In the delta lands this is rarely the case, especially south of the Memphis latitude. Labor, usually colored, lives as a tenant in two- or four-room houses scattered over the plantation, a "one-mule cropper" to every 18 or 20 acres and a "two-mule cropper" to 35 acres. Cotton is *the* crop, with corn a poor second, the latter growing less important farther south on account of the heat and drought at certain critical stages. Cotton needs heat and it stands drought well. Then, too, the development of the low-stalk, big-ear breed of corn remains to be worked out. Feed is always imported into the delta country. Alfalfa makes an excellent showing, but in a 130-mile drive southwest of Memphis, approximately one-half the distance in flooded territory, it appeared that cotton so completely claims the use of the land that only a few small haystacks were seen, not two dozen hogs, only two cows and scarcely a single truck patch. Later information from an engineer at Osceola explained that the tenant, often much to the disgust of the owner, picks for his truck patch the choicest bit of land somewhere in the cotton field.

By and large the owner's commissary or company store is the main source of feed for man and mule. However, there is said to be an increasing tendency to grow more feed crops. Mr. Hoover is said to have suggested the distribution of $125,000 worth of seeds from Red Cross headquarters to encourage the growth of other than cotton crops since the cotton planting season had passed when the land finally was freed of water.



ST. FRANCIS AND WHITE RIVER BASINS, MISSISSIPPI VALLEY

Probably 90 per cent of the Yazoo delta and 75 per cent of the Arkansas delta south of Memphis is tenant-farmed on the plantation system. Smaller acreages are the tendency in the recently reclaimed areas. In northern Arkansas still smaller holdings, more diversification of crops, and less tenant farming are coming. A majority of the farms west and north of Osceola are now not larger than 160 acres—barring an occasional large holding like that of ex-governor Lowden with his 15 sections of trough land, 2,500 acres of which are in cultivation, or that of Lee Wilson, the original drainage advocate, who owns the town of Wilson and 66,000 acres, one-third of it in cotton.

In the main three systems of bargaining with the laborer to "make a crop" are used: (1) Day-labor basis, the owner paying only for days worked. The usual wage is now $1.50 per day. Even by this method the laborer usually lives in a tenant house and has certain perquisites, but the owner furnishes all equipment. (2) Owner furnishes everything including tenant house, farm tools, mules, feed, seed and credit at the commissary; the split is 50-50. (3) Or, owner provides house and land only and gets one-third of the corn and one-quarter of

the cotton. The split may vary, depending on the condition of the ground as to drainage, freedom from stumps and "grass," and ease of working. In practically all cases the laborer needs and is given credit at the commissary for necessary food and clothing. Accounts are settled when the crop is gathered.

Under these labor conditions, naturally, the stability of labor against turnover presents a serious problem. In certain sections of the lower deltas above the Arkansas and Yazoo where a crop could not be made this year two-thirds to four-fifths of the families have moved away. In these districts farm-machinery salesmen have been busy, and farm experts are watching the result with some apprehension. For, while cotton is by no means a tender plant, it needs freedom from choking weeds and "grass" to make a good growth, and only close and careful hoeing will give the young plant the chance it needs.

Land Fertility—Just why does the cotton farmer stick to one crop? Repeatedly one hears that the delta lands are the richest in the world and will grow anything. Cotton needs rich soil and is said to be "hard" on the soil. Certain areas near Wilson were pointed out as having been continuously in cotton for more than 50 years without fertilizer. Even the barn manure is wasted.

What Does Clearing Cost?—Costs of clearing land vary so much one is rash to venture figures. An engineer who has done much drainage work and who also owns several hundred acres of land, part under cultivation and part being cleared each year, says that $60 per acre has been paid as a top figure for clearing right-of-way for drainage ditches while plantation clearing costs range from $10 to $18. The latter figures cover "deadening" the trees by girding and removing all underbrush so that a mule can work his way between the uncut larger dead trees. Complete clearing is quoted at from $35 to $60 by a farm expert of a mortgage house, but a farm manager says that $20 to $30 is enough if the large stumps are left to rot out, as they will in 8 to 10 years.

Cost of Growing Cotton—A large land owner and vice-president of a farm mortgage company made up the following table of costs per acre of raising cotton on the average well-cleared delta land producing ¾ bale to the acre:

Shaping land ready for seed	$5.00
Provisions for man and mule	15.00
Picking	20.00
Ginning, baling and ties	7.50
Seed	1.00
Rent	10.00
Depreciation on stock and equipment	2.00
Cost of ¾ bale or 375 lb	$60.50

This brings the cost to 15c. per pound. In Arkansas this year the average crop will hardly be ½ bale to the acre, which would mean still higher cost. On the other hand, an Osceola engineer says that most of the cotton this year will cost less than 10c. per pound to raise, and as the selling price is 24c. the monetary return will be large where any reasonable crop is obtained. Hence the optimism in these flooded areas which are getting any crop at all.

The crop was "made" cheap this year, for labor was efficient. Silted lands were well fertilized and "grass" was absent. In consequence, in many cases both owner and laborer are better off than last year when the selling price of cotton scarcely paid its cost of production. Further, the large amount of money distributed in one way and another for rehabilitation, the available places for day-labor work on levees, roads and railroads has helped the situation still more.

Land Values and Taxes

With possible returns of $30 to $60 per acre, naturally, the average cost of land becomes of prime interest. The question was put up to mortgage men, owners and engineers.

The answers indicate that only scattering sales are being made; that "taxes are eating us up" and buyers shy at assuming the burden. Road taxes of $2.50 per acre or more for abutting property have up to recently been backbreaking. A reduction of one-half for two years and in 1927 full assumption, was made by the state, paid for by the 5c. gas tax. Levee taxes are least of all, often being but 25c. per acre, ranging up to $1.50. Drainage-district assessments run from 50c. to $5.

It is a fact that thousands of acres are being sold for taxes. For undeveloped property taxes are prohibitory. Land that is once in cultivation finds the burden not so onerous.

The land boom of 1919 pushed prices to $225 and $250 per acre. Now good land can be bought for $100 and occasionally for $50 or $60. An 80-acre piece 20 miles west of Memphis recently sold for $15 per acre, but that was an isolated forced-sale case. It should have brought $60 to $70 per acre, said the finance expert. Unless there is timber on it, there is absolutely no sale for back-water land. Much of it will go back to the state for taxes, in the opinion of land dealers. For the last two or three years little new land has been cleared and brought into cultivation.

Drainage District Financing—The floods will weed out the weak drainage projects. Bond holders and bankers are taking a lenient attitude, and the stronger mortgage houses are paying interest coupons, taking debentures or unsecured coupon bonds from the better districts. The picture is rosier than one might think, said a mortgage company expert, for of 72 districts financed by one house, less than 20 per cent are in difficulty. Good district bonds in his opinion are as solid as ever, but the buyer should know what lands they cover.

Naturally, no new projects are going ahead, though in the Osceola region drainage work already under way is progressing. Property owners see the need as never before. Much of the land to be benefited was not covered, but seepage and high ground-water were nearly as disastrous as actual flooding.

While new drainage financing may be at a standstill, the banks as a whole are in excellent condition. The plantation owners are not in a much more extended situation than last year, for the banks had already curtailed extensions radically. A cheap crop, efficient attention to business and low general expense have been the rule. Few bank failures resulted from the flood, said F. D. Beneke, secretary of the Mississippi River Flood Control Association, who is closely connected with one of the principal banks in Memphis. As to profits in the banking business, few country institutions in the delta areas pay less than 20 to 30 per cent dividends; this on the authority of a land company official.

All of the above views must be considered fairly general as applying to the region tributary to Memphis in Arkansas and in the Yazoo delta. There are plenty of exceptions, but enough separate opinions are included to constitute a substantial assurance that the general statements are reliable.

Scars—A flood of the magnitude of that of 1927 is bound to leave scars, but in this upper-basin country six months' time and the indomitable will and energy of the people have done wonders in removing them. Roads that were under water and out of commission for 60 days show no evidence of washing to side ditches; except for their new gravel, no one would suspect that they had been flooded. In perhaps 200 miles of roads under water the worst places noted were in a 5-mile stretch north of Marked Tree, Ark., on a 10-ft. embankment. These consisted of perhaps a dozen washed-out sections of road 20 to 100 ft. long, replaced by hastily-built timber bridges.

At Clarendon, Ark., which lies by a great loop of the White River and is surrounded by a loop levee 10 to 12 ft. high to hill ground back of the city, the water topped the levees by 2 to 3 ft. High-water marks are everywhere visible. Few houses moved from their foundations, but a two-weeks' soaking made many of them lose their visible stability. In many structures of simple nature, sags are all too evident. Furniture on first floors was ruined. Several stores have not reopened. People interviewed are optimistically expectant of aid for better levees, and say they cannot stand another flood—the last prior to 1927 was in 1916.

Levee breaks (in more than 100 places) are practically closed now, and an additional 2 ft. has been added to the crown in long stretches. A peculiar washing out from the center occurred. It started apparently due to swirls attacking the bare spots in a path on the crown not protected by the heavy growth of bermuda grass.

Many tenant houses in the lower reaches floated away. These are usually two- or four-room, simple, unpainted frame shacks occupied by farm labor, and originally cost, I was told, $300 and $500 respectively. Salvage of lumber (if the planter can locate his houses and the distance away is not too great) will rebuild about one-third of the original number of houses.

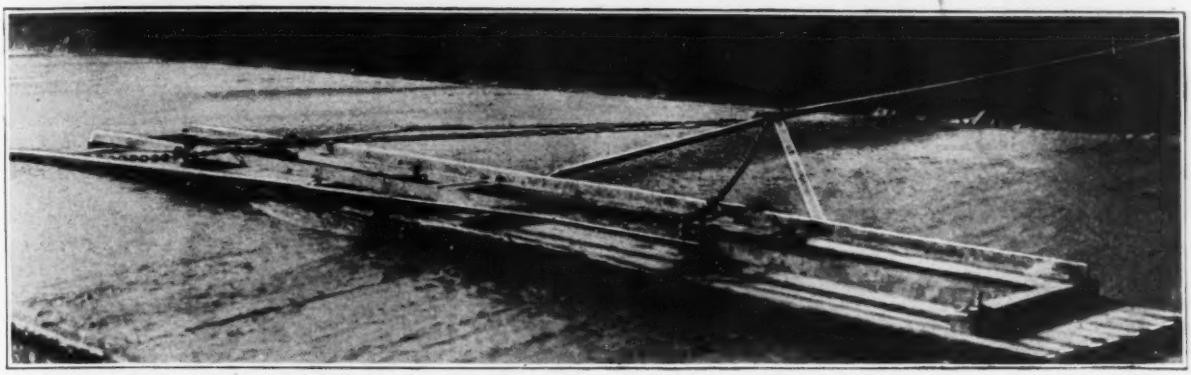
This, then, is the type of land, some of the characteristics of its methods of use and how the people who live on it make their way. It is not like Iowa. The short distance between houses tempts one to compare it with certain areas of California but only in that respect on closer study. Higher levees on the main river, safe protection levees on the tributaries, revetments, auxiliary channels and all the other improvements suggested will insure these people, owners and tenants, against inundation and permit utilization of these rich lands without interruption. Practically all are confident that eventually such insurance will be obtained.

Fast Force-Account Road Building in North Carolina

Nearly Eight Miles of Concrete Road Constructed in 436 Working Hours of 31 Days Using Acetylene Lights at Night

By L. R. Ames
State Highway Engineer, Raleigh, N. C.

IN BUILDING a section of road in Jones County from Maysville to Pollocksville, N. C., in 1926, the wonderful progress was recorded of 7.7 miles of concrete pavement 16 ft. wide and 6 in. thick, built in 31 working days, or a total of 436 working hours. This work was performed by a state force outfit that had been organized only about eight months. R. E. Snowden, district engineer of the second district, had charge of the engineering work.



LONGITUDINAL WOOD FLOAT TO TAKE OUT IRREGULARITIES

The equipment was a standard 21-E mixer, a steam crane with a 1-cu.yd. bucket, and 1-ton trucks for hauling the aggregate. The unloading plant was located approximately in the middle of the project with the average haul about two miles. All materials came in by rail in 35 to 50-ton cars. Daily shipments of 3 cars of cement, 8 cars of fine aggregate and 16 cars of coarse aggregate were required to keep the operation moving, and the unloading plant was so located as to permit stocking the material when weather compelled stopping work, which occurred several times during the time of construction.

PLACING WET BURLAP ON FINISHED SURFACE

However, the majority of the car shipments were unloaded direct from the car to the bins, thus eliminating double handling. At the unloading plant adjacent to the side-track two timber bins were erected, one of 70-ton

TRANSVERSE FLOAT TO BRING MORTAR TO SURFACE

capacity for stone and the other of 35 tons for sand. Nearby was located a cement shed of 10-car capacity, or approximately 2,500 bbl.

A 6-sack batch was used, and in placing the concrete the crew employed at the mixer was composed of a foreman and from 22 to 24 men, which included puddlers, men on screeds, subgrade trimmers, finishers, laborers for placing and sprinkling burlap, and one for calcium chloride. To keep the mixer supplied with materials, from 35 to 45 trucks of 1-ton capacity were first loaded at the stone bin with coarse aggregate, then at the second bin with fine aggregate, and on this was deposited the loose cement which was protected from blowing away by canvas covers.

Notwithstanding that our specifications require that the concrete be mixed 1½ min., batches were turned out from the mixer at about every 1 min. 45 sec. The average daily linear feet laid was 1,315 ft. for the 31 days, while the maximum day's run was 2,400 ft. The daily time of work varied from 3 hours to 24 hours; on several days rain stopped operations, in one instance for an entire week, while on two other occasions the breaking of equipment caused a shut-down as shown by the accompanying log of operations.

PROGRESS SHEET OF ROADWAY CONSTRUCTION

Day	Linear Feet Laid	Cement Record: Bags Used	Bags per Foot	Bbl. per Cu.Yd.	Hours Worked
29	721	1,278	1.77	1.49	10
30	1,000	1,794	1.79	1.51	12
	861	3,072	1.79	1.51	22
		APRIL			
1	.....	.....	....	....	..
2	1,279	2,394	1.87	1.58	13
3	665	1,200	1.81	1.53	7
4	Sunday				
5	.....	.....	....	....	..
6	1,525	2,724	1.79	1.51	16
7	1,510	2,700	1.79	1.51	16
8	467	840	1.80	1.52	3
					Rain stopped work
9	1,888	3,454	1.83	1.54	17
10	775	1,416	1.83	1.54	8
11	Sunday				
12	.....	.....	....	....	Rain, no work
13	.....	.....	....	....	
14	.....	.....	....	....	
15	.....	.....	....	....	
16	.....	.....	....	....	
17	.....	.....	....	....	
18	Sunday				
19	2,105	3,822	1.82	1.54	20
20	.....	.....	....	....	..
21	1,535	2,778	1.81	1.53	16½
22	440	816	1.85	1.56	4½
					Mixer broke down
23	2,220	4,044	1.82	1.54	24
24	640	1,182	1.85	1.56	8
25	Sunday				
26	1,475	2,724	1.85	1.56	16
27	1,535	2,760	1.80	1.52	16
28	1,625	2,908	1.79	1.51	16½
29	1,735	3,156	1.82	1.54	17½
30	.....	.....	....	....	..
	1,339	38,918	1.82	1.54	219
		MAY			
Apr. 30 and May 1	3,870	6,894	1.78	1.50	35½
2	Sunday				
3	.....	.....	....	....	..
4	754	1,362	1.81	1.53	8
5	490	900	1.84	1.55	5½
					Crane broke down
6	.....	.....	....	....	..
7	1,455	2,700	1.86	1.57	16
8	.....	.....	....	....	..
9	Sunday				
10	1,310	2,400	1.83	1.54	15
11	1,475	2,814	1.91	1.61	16
12	1,245	2,340	1.88	1.59	15
13	Moving				
14	1245	2358	1.89	1.59	16
15	485	900	1.86	1.57	6
16	Sunday				
17	1,205	2,208	1.83	1.54	15
18	1,250	2,274	1.82	1.54	15
19	.....	.....	....	....	..
20	1,537	2,772	1.80	1.52	17
21	.....	.....	....	....	..
22	.....	.....	....	....	..
23	Sunday				
24	1,288	2,370	1.84	1.55	15
		32,292	1.83	1.54	195

BOW BELT FOR FINAL FINISH

For mixing and preliminary curing, water was obtained from local streams and pumped through a 2-in. pipe line for a maximum distance of two miles. Two pumps were rigged up for supplying the water, one being used in cases of emergency. The admixture of a 2 per cent solution of calcium chloride for curing purposes was placed in the mixer-drum by means of a small force pump. The solution dissolved in barrels placed on a platform erected on the side of the mixer was pumped into a measuring tank which held the required amount for each batch.

Approximately 3,500 lin.ft. of steel forms were required, which enabled a sufficient distance to be placed in advance of the mixer outfit. The fine-grading crew was of sufficient size to keep well in advance of the form-setting gang which had difficulty at times in keeping the required minimum distance of 200 ft. ahead of the mixer. Two screeds were used, each weighing over 400 lb., to

strike off the concrete, followed by a transverse board float to bring a mortar to the surface. A longitudinal wooden float weighing about 200 lb. was later used to take out surface irregularities, and a final finish was given by means of a bow belt made of canvas rubber. As our specifications require the removal of all surface variations exceeding $\frac{1}{16}$ in. per foot, previous to the final belting the pavement was tested with a 10-ft. straightedge, of weight sufficient to permit easy handling, and if any irregularities were found, they were floated out by means of the two floats before the final belting. The surface of the pavement was covered with strips of burlap, kept wet for 24 hours and in 10 days the road was opened to traffic.

To permit working at night both the plant and mixer were lighted with acetylene lights, which gave sufficient illumination to permit operations without any difficulty whatever.

The construction record made on this project was the cause of much comment throughout the state last year. Too much credit cannot be given C. S. Gale, superintendent now deceased, and his organization for their untiring efforts and hard work in putting across an unprecedented task in road building in this state.

Study of Sewage Settling Tank Design

Theory of Flow in Settling Tanks and Comparison of Operating Efficiency of Various Types With Conclusions As to Factors that Should Govern Design

By C. H. Capen, Jr.
Consulting Engineer, East Orange, N. J.; formerly Assistant Sanitary Engineer, New Jersey State Department of Health

ALTHOUGH many branches of engineering have made rapid strides in the last few decades it is astonishing to note how little improvement has been made in the design of sewage settling tanks. In fact, practically no change has been made from the original design introduced about forty years ago until Dr. Imhoff produced the tank that now bears his name. Even this type has changed little so far as the shape of the settling compartment is concerned and the conditions of special features dealing with the sludge often govern the design to the exclusion of study of the settling compartment. During several years spent with the New Jersey State Department of Health, the writer visited about two hundred sewage settling tanks and studied their design and operation sometimes in great detail. As a result of these observations and much reading and study, some definite conclusions as to desirable features of design have been formed and are herewith presented for the first time.

Capacity and Efficiency—The first point and often the most important is the capacity of the tank. (For purposes of theoretical discussion one tank only will be considered.) To arrive at the required capacity the usual method is to use a factor known commonly as the "detention period" which is a much misused term. It has been defined in some standard books as "the volume of the tank divided by the rate of flow." Obviously this is a theoretical figure and bears little relation to the results that can be obtained under various conditions. This fact was first emphasized by Prof. Charles G. Hyde of the University of California, who coined the term "flowing-through period." The writer has adopted this term and has made the following definition: "The average time required for a small unit volume of sewage to pass through a tank at a given rate of flow shall be called the *flowing-through period*."

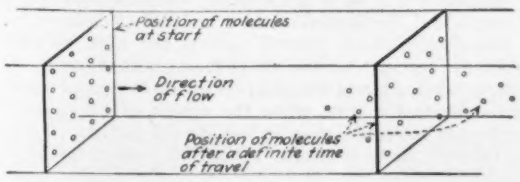


FIG. 1—FLOW OF MOLECULES THROUGH A TANK
The distance between the centers of gravity of each, represented by the two planes, gives the average time of flow.

With this information in mind it is apparent that the most efficient tank, so far as complete utilization of its settling capacity is concerned, will be one in which the ratio of the flowing-through period to the detention period is unity. This ratio (expressed in per cent) will be termed the *efficiency rating*, and it is a direct measure of the economy of design of the tank. In practice, this varies from about 50 in the case of some well designed tanks to 20 or 15 or even less in the case of others.

Using this information as a basis the following equation becomes apparent:

$$\text{Efficiency rating} = \frac{\text{Flowing-through period}}{\text{Detention period}} \times 100$$

Let C = Capacity of tank in gallons.
Q = Rate of flow in gallons per day.
E = Efficiency rating in per cent.
F = Flowing-through period in hours.

$$D = \text{Detention period in hours} = \frac{C}{Q} \times 24.$$

$$\text{Then } E = \frac{100F}{D} = \frac{100F}{24\left(\frac{C}{Q}\right)} = 4.17\,\frac{FQ}{C}$$

It is useless to refine the equation further, as $\frac{Q}{C}$ will differ for each tank or condition of flow and F must be determined experimentally.

Principles of Flow and Early Tests—The principles of the flow of a unit volume of sewage through any medium, whether it be stone, sand or sewage, are fundamentally the same. The actual lag or variation in the appearance of a given unit volume at the outlet (the unit having been more or less cohesive and evenly applied at the inlet) will vary in accordance with the type of medium and with many other factors.

Tests to determine the amount of this lag were made at the Lawrence, Mass., sewage experiment station over twenty years ago, but these tests were mostly on filters of various sorts, and tanks were not tested until 1917. At first dye was used and observed at the outlet end, but

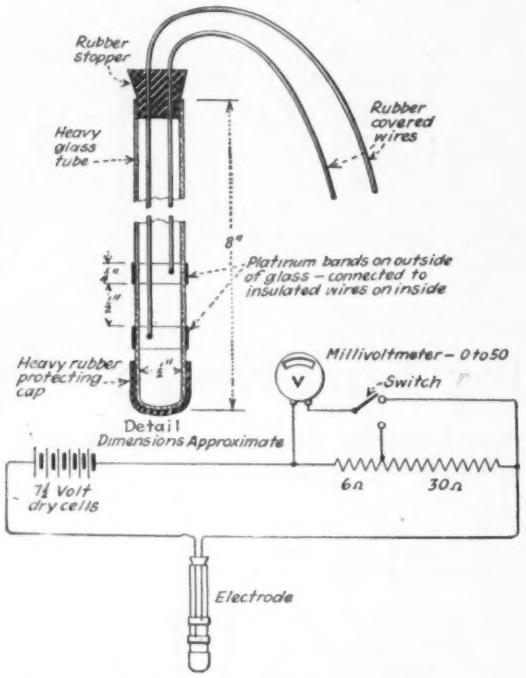


FIG. 2—CIRCUIT AND ELECTRODE DETAILS FOR DETERMINING CHLORIDE CONTENT

This apparatus was developed particularly for ease in testing settling tanks. It has given very reliable results when subjected to various tests in the laboratory but has not yet been used for field tests.

later the method employed was to apply sewage at an even rate of flow and then to introduce a salt along with the sewage flow (without changing the rate) for a protracted period. Tests for chlorides were made of the effluent and the results showed that the chloride content increased sharply at first and then more gradually until the amount at the outlet finally equaled or nearly equaled the amount being added at the inlet. Obviously the time required to have the effluent value equal the influent value is not the average time required. This objection was first raised by William Clifford in England in 1907. The following abstracts from two of his papers are of interest in this connection (*Journal of Chemical Industry*, Manchester Section, July 15, 1907):

The method of determining this time (the time taken by a liquid to pass through percolating beds) appears to have been simply to pour a quantity of colored liquid on the surface of the bed while in action, and note the time between the pouring of the liquid and the first appearance of color at the outlet. By this method the time of passage of a comparatively small portion of the dose or added liquid is measured. It takes no account of the bulk of colored liquid poured over the surface. Now, there appears to be no reason why the first trace of a given dose appearing at the outlet should be taken to indicate the time of passage of that dose, any more than the last trace. It will, therefore, be necessary to define what is meant by the time of passage of liquid through a bed. The time of passage of any portion of liquid may be defined as the average time of passage of all the molecules of that portion of liquid. For practical purposes, it will be sufficient to find the general distribution of the observed liquid in the effluent, and from this to calculate the mean distribution; this gives the average time.

In a manner similar to that used at Lawrence an even rate of flow was obtained on a test filter, but with the change that only one dose of salt (replacing an equal portion of the uniform flow) was used. Samples of the effluent were tested for chloride content. The method of computing the results was:

The combined chlorine in the samples gives the distribution of the chloride in the effluent. The average time of passage is obtained by calculating by the method of moments the mean frequency of the combined chlorine, after first reducing the amount by that present in the water previous to the addition of the solution, and is given by $\Sigma\ P\ Q \div \Sigma\ Q$ where P is the minute corresponding to the combined chlorine Q.

It is further stated that the position of the centroid vertical (i.e., a vertical through the center of gravity of a curve plotted with minutes as abscissas and chlorine as ordinates) corresponds to the mean frequency. Further experiments by Mr. Clifford are discussed in a later paper and extracts are given (Reprint from same *Journal*, July 15, 1908, Birmingham and Nottingham sections):

It may be useful at the outset to state the usual meanings attached to the world "flow" as applied to liquids. Qualitatively, it indicates merely change of position; quantitatively, the change of position of a *volume* of liquid in a certain time. The word is used in both senses in works on hydrology. There is, however, another meaning, which will be referred to as the velocity-flow, as distinct from volume-flow. By velocity-flow is meant the distance between two given cross-sections of the stream divided by the time occupied by one or more particles of a liquid, in passing from one section to another.

When a solid body changes position, the time taken to travel from one position to another is in general easily determined, but with a liquid the case is different, the particles are constantly changing position relative to one another, so that "change of position" may either refer to the change of position of a particle or to the change of position of the center of gravity of a number of particles. For obvious reasons the change of position of the center of gravity of a number of particles is often utilized in mechanics, but the application in this connection is perhaps somewhat new.

Consider water to be flowing steadily through a tank or trough, and suppose the particles or molecules in a section at any given instant to be recognizable (Fig. 1). These particles or molecules have a common center of gravity; that is, there is one point in space about which the molecules are in equilibrium at that instant. Since the liquid is flowing through the tank, all recognizable molecules must pass through every section between the one above mentioned and the outlet. After a time the center of gravity of the particular molecules will be in a section at some distance from the first one, and if the number of these molecules passing through the second section be plotted against the time of passage between the sections, some such curve as that shown . . . would be obtained, and the position of the "centroid vertical" would indicate the time when the center of gravity of the recognizable molecules was in the second section. (Note—Mr. Clifford's curve is similar to the Red Bank curve, Fig. 4.)

Mr. Clifford then said that this is exactly what was determined by the method given in his previous article. He criticized the Lawrence method and showed that by finding the centroid vertical, on the curve obtained from that method, the time elapsed would be the same as that found by his own method. In other words, using the same medium and rate of flow and plotting the curves on the same scale, the centroid verticals would coincide. He further checked this experimentally by using both methods and in addition he showed that by reversing the Lawrence process (i.e., adding a constant chlorine solution and replacing by a constant addition of water) the same result would be obtained as by the other two methods (using the centroid vertical for determining the average time of passage). He also stated that "the time

of passage of water through a medium is directly proportional to the amount of water in motion in the medium." This agrees with the conception that the most efficient tank (within reasonable limits) is one in which the ratio of the flowing-through period to detention period is greatest. Another interesting statement by Mr. Clifford was: "Although there is reason to believe that the molecules of different substances have different velocities when in solution, yet it is highly probable that the average forward movement of the molecules of a solute does not differ appreciably from that of the molecules of the solvent."

Application of Theory—Using the theories advanced by Mr. Clifford as a basis, a number of different types of settling tanks were tested for efficiency rating in the following manner: A bag of commercial salt, usually 50 to

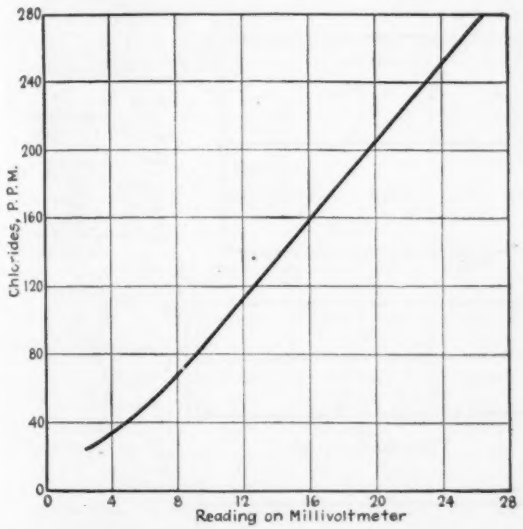


FIG. 3—TYPICAL CALIBRATION CURVE FOR ELECTRODE

This curve was made from readings taken from samples of tap water of low solid content to which known quantities of sodium chloride were added, for drop across a 36 ohm resistance. Since the curve is practically a straight line, it is not absolutely necessary to convert readings into chlorides, except for purposes of checking with one or two titrations, because a curve of a tank test plotted from millivoltmeter readings will give the same location of the centroid vertical as one plotted from chlorides.

85 lb., was dissolved in a large tub of water, hot water being preferred, and the solution was emptied into the sewage entering the tank at a given time. Samples were taken from the tank effluent at 5-min. intervals and analyzed immediately for chlorides. As soon as an increase was noted, the interval was shortened to 2 min., later being increased to 5 min., when the peak was well passed. In all cases the rate of flow was read from a weir or other device during the test and the weighted average was computed. Then using Mr. Clifford's method, the flowing-through period was obtained by computing the location of the centroid vertical, while the detention period was obtained by dividing the volume of the tank by the rate of flow determined from the weighted average. The ratio of these two results immediately gave the efficiency rating.

The only tedious part of the method described above was in titrating the samples for chlorides. The titration was relatively simple, one-tenth normal silver nitrate being used with potassium chromate as an indicator (see "Standard Methods"). A large increase in chlorides during the run sometimes necessitated changing the amount of samples used but this was of little importance so far as time was concerned. It is interesting to note that frequent check-ups showed that the incoming sewage seldom, if ever, changed enough in chloride content during a test to affect the result. Therefore the normal content was taken as a zero value for determining the centroid vertical. One man was kept very busy titrating, however, and if two or more tanks were being tested simultaneously, many samples had to be kept over and tested later.

Later Improved Methods—In further studies it became apparent that an electrical method could easily be substituted. A study of the tests of Allen and Taylor of Worcester showed that this was entirely feasible. Field experience showed, however, that many obstacles would be encountered which would impose conditions that would render their apparatus too complicated for this purpose. Accordingly a special arrangement of apparatus was constructed (Fig. 2), the electrodes having been made to order by one of the large laboratory supply companies.

This apparatus operates as follows: A source of electrical energy exists in the dry cells. When the electrode is immersed in a liquid a current flows, the amount being dependent on the conductivity of the liquid. If all other conditions remain equal, the current flow will vary in a certain relation to the salinity of the liquid. Thus the salt introduced can be made to vary the flow of current. It is possible to measure the flow by a milliammeter, but since only a millivoltmeter was available it was substituted and was so arranged that it measured the voltage drop across a resistance. The greater the current flow, the greater will be the drop across the resistance. For a given range of chloride content, the resistance used was 6 ohms, while for a lower range 36 ohms was required. That is to say, the greater the conductivity the greater will be the voltage drop across a resistance, hence a double range resistance must sometimes be used so that the readings will fall within the limits of the scale.

This apparatus was carefully tested in the laboratory, but has not yet been given a thorough field test. Laboratory results showed that the accuracy was well within the limits of the accuracy of titration. A typical calibration curve is shown by Fig. 3.

The readings should be calibrated against solutions of the sewage being tested containing known amounts of chlorides. It would be well, however, to run check titrations at the time of a field test, from samples taken before and at the peak of the chloride run. It should be noted that the source of d.c. potential will cause the electrodes to polarize, this process taking about half a minute. After this, the current flow will be constant for a given conductivity and no difficulty should be experienced. The electrode should not be disturbed while a test is in progress.

Results Obtained by Chemical Tests—The accompanying curves (Fig. 4) show results obtained from tests made by the titration method. As stated before, the zero line of chlorides is taken as the normal chloride content, and from any one result this fixed quantity must be subtracted in order to get the result from which a point on the curve is obtained. It is very noticeable that there is always a secondary hump, usually only a flattening of the curve, for every tank. Of course where two or more tanks operate in parallel, two or more peaks may be expected. These curves are designated so as to correspond

with the cross-sections and plans of the tanks (Fig. 5) from which they were derived. In addition, a table is given showing the various conditions as well as the actual removal of solids in cases where these were obtained.

As a check on the use of salt, a dye was frequently introduced at the same time as the salt. The appearance of the deepest color at the outlet end usually agreed quite closely with the peak of the chloride test, but the dye always disappeared before the last trace of the chlorides.

To show how widespread the misconception as to the use of color has become, the following is quoted from *Engineering News* for Jan. 6, 1916, in an article trans-

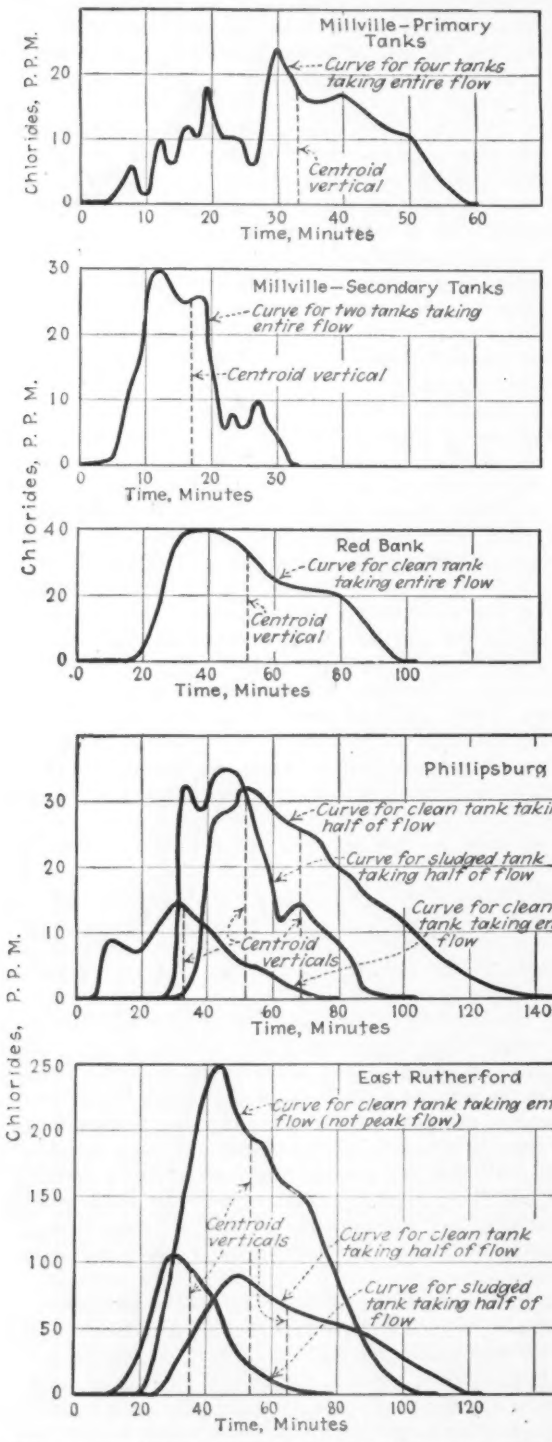

Millville—Primary Tanks
Curve for four tanks taking entire flow
Centroid vertical
Chlorides, P. P. M.
Time, Minutes
Millville—Secondary Tanks
Curve for two tanks taking entire flow
Centroid vertical
Red Bank
Curve for clean tank taking entire flow
Centroid vertical
Phillipsburg
Curve for clean tank taking half of flow
Curve for sludged tank taking half of flow
Curve for clean tank taking entire flow
Centroid verticals
East Rutherford
Curve for clean tank taking entire flow (not peak flow)
Centroid verticals
Curve for clean tank taking half of flow
Curve for sludged tank taking half of flow

FIG. 4—CHLORIDE CURVES OBTAINED FROM SEVERAL TESTS OF TANKS

Plotted from chloride titrations, the rapid variations showing the large number of samples required, involving a great amount of manual labor. The multiple peak effect when two or more tanks operate in parallel is particularly noticeable, as well as the effect of sludge.

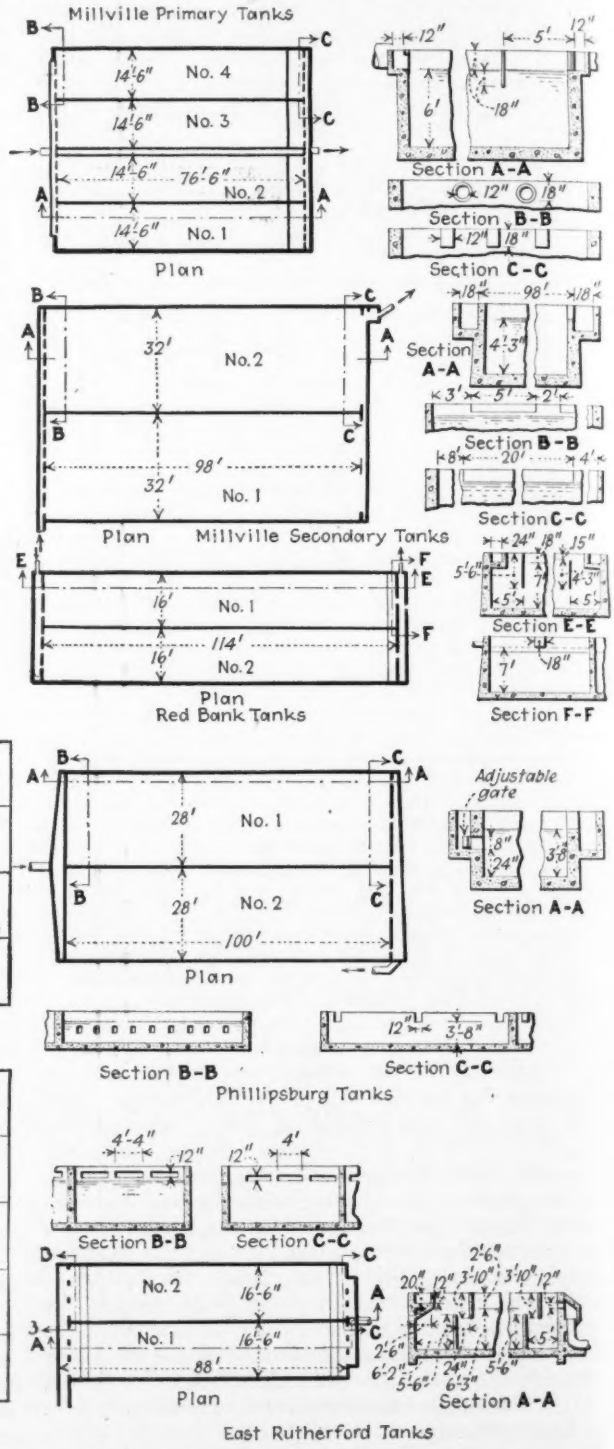


FIG. 5—PRINCIPAL DESIGN FEATURES OF TANKS TESTED

Illustrating the diversity of the types tested. Results show the Phillipsburg tank to be the best, due, no doubt, to the carefully arranged inlet. The detrimental effect of a side entrance as at Millville (secondary) and East Rutherford is also noticeable. At Red Bank only one tank was tested, so this effect could not be studied.

lated by Leslie C. Frank from an original written by Dr. Karl Imhoff: "By detention period here is always meant the computed detention period. The actual detention for part of the sewage is naturally less because of short-circuiting; it can be determined by means of dyes placed in the influent." This is obviously proven to be a false impression.

Criticism of Tanks Tested—(See Fig. 5.) The Phillipsburg tanks are by far the most efficient, largely on account of the very good arrangement of the inlets. The outlet end is not well designed and dye placed in the tank showed that the currents started to "cone in" toward the outlet weirs from a distance of 20 ft. or more back. The Millville primary and Red Bank tanks are examples of the old school of design—with poor results. The Millville secondary tanks correspond in some respects to the Phillipsburg tanks, but the overfall inlet

Recommendation as to Design—It is not possible to state accurately in advance what the flowing-through period will be. By using reasonable care in design, it is believed that an efficiency rating of 30 per cent can be obtained. The writer suggests that single-story settling tanks be designed with a detention period of 8 hr. and Imhoff tanks 2½ to 4 hr., and that longer periods be allowed whenever experimental determinations after construction show an efficiency rating of less than 30 per cent under conditions of average flow. This is equivalent to saying that single-story tanks should have a flowing-through period of not less than 2.4 hr. and Imhoff tanks not less than 0.75 to 1.2 hr. Other types would have to be considered on their individual merits. The periods given are perhaps higher than some engineers recommend, but are believed necessary under conditions found at the average plant.

EFFICIENCY RATING OF SETTLING TANKS AT SEWAGE-WORKS OF FOUR NEW JERSEY TOWNS

The ratings appear in Col. 7 and are derived from chloride tests. See Fig. 4 for corresponding curves and Fig. 5 for plans and sections of tanks.

Town	Tank No. Col. 1	Tank Capacity M.G. 2	Flow, M.G.D., Total 3	Flow, M.G.D., Through Tank 4	Detention Hr. Min. 5	Flow Thro, Min. 6	Efficiency, Per Cent 7	Condition 8	Removal of Solids Per Cent 1 Hr. Settleable 9	Removal of Solids Per Cent Suspended 10	Ratios Length to Width 11	Ratios Area to Depth 12	Remarks 13
Millville.....	Primary tanks 1, 2, 3, 4	0.200 total or 0.050 each	1.5	1.5 total or 0.375 each	3–12	33	17	¼ scum and sludge	....	74	5.3	185	Four tanks operating in parallel
Millville.....	Secondary tanks 1, 2	0.200 total or 0.100 each	1.5	1.5 total or 0.75 each	3–12	17	9	Clean	....	34	3.1	740	2 tanks operating in parallel
Red Bank.....	2	0.095	0.5	0.5	4–34	52	19	Clean	96.5	..	7.1	260	Tank 1 not operating
Phillipsburg....	1	0.077	1.5	0.75+	2–25	70	48	Clean	81	..	3.6	760	Two tanks operating in parallel
	2	0.077		0.75—	2–25	52	36	¼ sludge	79	..	3.6	760	Tests made on each tank
	1	0.077	1.0	1.0	1–49	33	30	Clean	89	..	3.6	760	One tank taking entire flow
East Rutherford	1	0.068	0.55	0.55	2–58	54	30	Clean	....	..	5.3	230	One tank taking entire flow
	1	0.068	0.5	0.25+	6–32	65	17	Clean	....	..	5.3	230	Two tanks operating in parallel
	2	0.068		0.25—	6–32	35	9	¼ sludge	....	..	5.3	230	Tests made on each tank

produced detrimental velocities which the widespread outlet could not overcome. The East Rutherford tanks show to a remarkable degree what poorly placed baffles can do. With one tank taking the entire flow, the inlet velocity was sufficient to effect a good distribution of the flow and produce a fair efficiency. With a smaller flow the baffle design was such as to permit a "film flow" through the tank and thus a poor efficiency was obtained.

Conclusions—As a result of these tests and from numerous observations the conclusions reached are:

(1) The majority of settling tanks are inefficient.

(2) The presence of excessive amounts of sludge and scum reduce efficiency.

(3) The most efficient tank is one with an even distribution of flow at both inlet and outlet ends, both being preferably submerged and arranged symmetrically.

(4) The depth of the tank has little effect on its efficiency if it is well designed.

(5) Long narrow tanks are not generally as good as those with a ratio of length to width of between 4 to 1 and 5 to 1.

(6) Baffles can be helpful but are more often detrimental than useful.

(7) Velocity is an unimportant factor in design, although high accidental velocities due to sludge accumulation may be harmful. If the design is correct the velocity will take care of itself.

(8) Analyses for solids will not always agree with the efficiency rating, but are somewhat consistent.

It is regretted that no circular tank was tested, but from observations the writer is convinced that at least for small installations a circular tank can be made very efficient, probably more so than a rectangular tank. This is stated in spite of the fact that the Baltimore circular tanks were not altogether satisfactory, but in that case special features created unusual conditions.

Other Applications of This Theory—The same theory may be applied to any settling problems, such as coagulation for water filtration plants, chemical precipitation processes and similar cases.

This work was done under the direction of H. P. Croft, chief engineer of the New Jersey State Department of Health. Appreciation is also expressed for the co-operation of P. N. Daniels, formerly senior sanitary engineer, and F. E. Whitehead, sanitary chemist, both of that Department, and for the help and suggestions of John R. Downes, superintendent of the Plainfield disposal plant. The opinions, however, are those of the writer.

Engineer or Engineman

The union of locomotive enginemen in Australia was authorized recently by a federal court to change its registered title to the Australian Brotherhood of Locomotive Engineers. An appeal against the decision was made by the railway commissioners of the several states and by the Association of Railway Professional Officers of Australia. According to the *Railway Gazette*, London (England), the judge in allowing the appeal said: "In Australia, the term 'engineer' had been applied to either skilled mechanics engaged on the construction of machinery, or to persons of professional status engaged on designing and supervising the construction of machinery, rolling-stock, bridges, etc. Those who attended to engines after construction had always been classified as engine-drivers or enginemen, and their registration under the title of 'engineer' might be a source of confusion." As to the judge's reference to "skilled mechanics," it must be remembered that, in English custom, the term "engineer" is commonly applied to men who in America are termed "machinists."

Ingenious Form-Handling on Covered Reservoir

Table Form Panels Moved Ahead on Carriages Enables Repeated Use and Cuts Cost of Lumber and Carpenters in Constructing Providence Reservoirs

MOBILE roof slab forms, with distribution of concrete by light motor trucks traveling on the forms, are obtaining unusually smooth progress in covered reservoir construction for the enlarged water supply of Providence, R. I. The structures are the familiar type for depressed reservoir: slab floor, columns on raised pedestals, flat roof with drop panels over the

FIG. 1—INSIDE VIEW IN COVERED RESERVOIR FOR PROVIDENCE WATER-WORKS

columns, and reinforced walls of uniform thickness from top to bottom, tied into both roof and floor. The type is well indicated by the view, Fig. 1. One reservoir, the Neutaconkanut, is 400x600 ft. and the other, the Longview, is 200x320 ft. The larger structure was begun first and as it exemplifies the construction methods for both it alone will be described, with some notice of the changes introduced into the newer operation following experience on the older.

The quantities of concrete to be placed were about 24,600 cu.yd. at Neutaconkanut and 9,200 cu.yd. at Longview. At Neutaconkanut about 55 per cent of the volume was in column and roof structure and 45 per cent in walls, floor and gate house. At Longview these percentages were respectively 39 per cent and 61 per cent. Roughly, in the larger structure the contractor had to place a little over a cubic yard of concrete per square yard of reservoir area, and in the smaller structure about 1.3 cu.yd. per square yard. The division according to construction procedure is floor construction including column pedestals; wall construction; and roof and column construction. The conditions governing concreting thus called for mobile delivery to forms and quick and easy form shifting. The construction plan centered around these two requirements. It was worked out a little differently for wall construction and for other

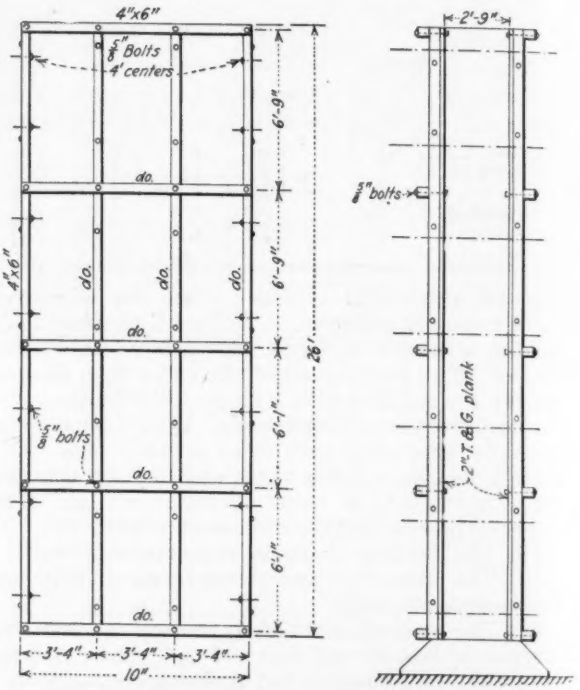


FIG. 3—TYPICAL RESERVOIR WALL-FORM PANEL

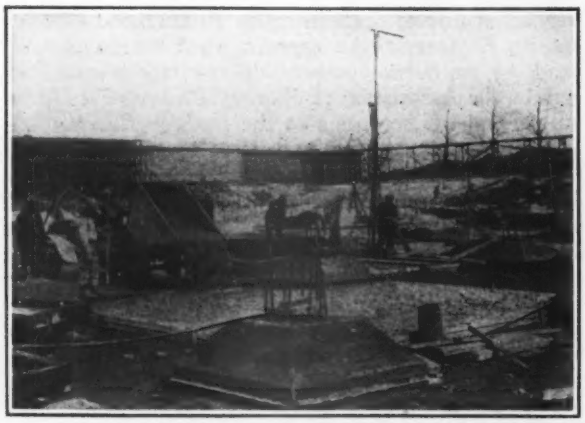


FIG. 2—MOTOR TRUCKS CONCRETING RESERVOIR BOTTOM

concreting but was otherwise uniform for each reservoir and in general alike for both. The notable management feature of the plan is that form construction and handling on the larger operation are subcontracted while on the smaller operation both form work and reinforcing are in the hands of subcontractors.

Floor Construction—The excavation was in hardpan with power shovels and motor trucks and was without unusual incident. The hardpan, however, gave not only a good foundation bed for floor slab and wall and column footings, but excellent ground to work over. With the wide spread of operations, delivery by motor truck from a central mixing plant fitted well the conditions of floor and column pedestal concreting. Normally, the column footings 5½ ft. square, were concreted first. Then the floor slab was concreted in 20-ft. square blocks, Fig. 2. The floor slab was 6 in. thick and unreinforced except the

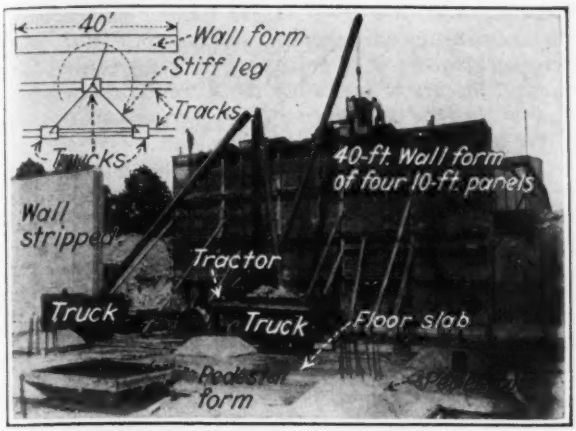


FIG. 4—TRAVELING STIFF-LEG OUTFIT FOR BUILDING RESERVOIR WALL

peripheral bays which had 15-in. floors reaching under the walls and under the first row of columns and which were heavily reinforced, transversely. In the joints between floor blocks 4x¼-in. steel plates formed the water stops and in the joints between floor slabs and column

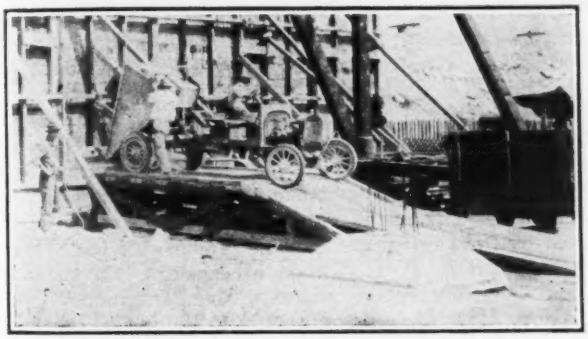


FIG. 5—RAMP FOR FILLING DERRICK BUCKETS FROM MOTOR TRUCKS

footings a crimped copper water stop provided for unequal settlement of pedestal and floor. Formwork was, of course, insignificant on the bottom and truck haulage at its easiest. As the bottom was built in the fall of 1926 and had to stand through a winter it was flooded with water 16 in. deep on Dec. 4 just before reservoir work at Neutaconkanut was closed down for the winter. The Longview work has been entirely a 1927 operation.

Wall Construction—Wall work was the first in which form handling became important. This and the columns and roof were subcontracted to the Deslauriers Column Mould Co., Boston, Mass. On the Longview work all walls were 25 ft. high above footings and 33 in. thick; at the larger reservoir about half the wall was 33 in. x 25 ft. and

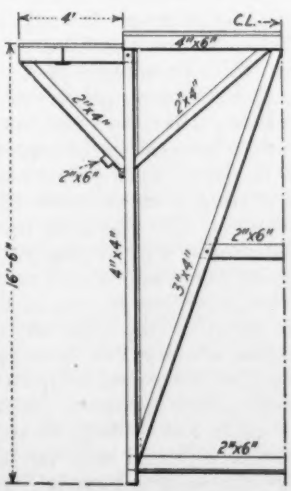


FIG. 6—HALF SECTION OF TABLE-FORM PANEL FOR RESERVOIR ROOF

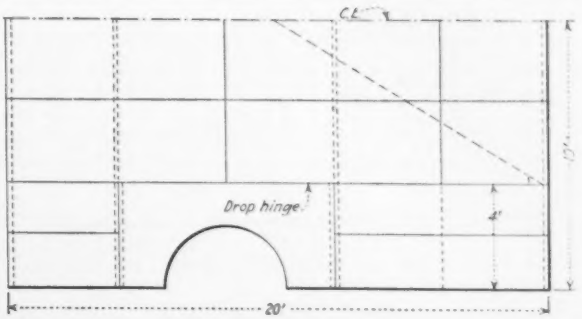


FIG. 7—HALF TOP PLAN OF TABLE-FORM PANEL

half 20 in. x 15 ft. Except in panel height, 16 ft., the forms for the low walls were like those for the high walls which alone will be described. Fig. 3 shows the construction as developed for the Longview work after some experimenting with wider panels at Neutaconkanut. The notable feature is the full-wall height of the forms and the pouring of the concrete full-wall height in 40-ft. lengths. This called for strong tie-bolting and rigid panel framing. A maximum concrete pressure of 600 lb. per sq.ft. was assumed with 1,200-lb. extreme fiber stress on timber and 20,000-lb. per sq.in. on bolts. With the spacing shown on Fig. 3, ¾-in. bolts through the studs entering cone nuts carrying 1-in. bolts through the walls, gave ample spading space for men working inside the forms and did away with holes through the wall. The cone nuts also facilitated quick dismantling of forms.

To erect and strip wall forms a stiff-leg derrick

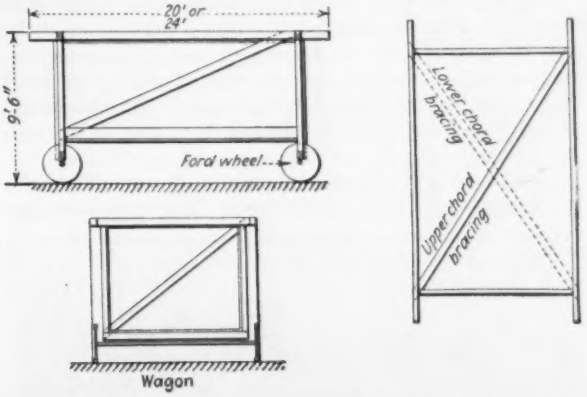


FIG. 8—CARRIAGE FOR SHIFTING TABLE-FORM PANELS

mounted on trucks and running along parallel industrial tracks picked up, carried and set up the panels. This same outfit, shown by Fig. 4, also placed the concrete with 1-cu.yd. center-dump buckets receiving concrete from the motor trucks. Fig. 5 shows the portable ramp used by the motor trucks for dumping into the buckets. The 40-ft. length of wall was concreted full height, 25 ft., as fast as could be; often the work was finished in 8 hours. A Fordson tractor shifted the derrick along its tracks. The concrete trucks were Fords with Lee dump bodies, 1-cu.yd.

Column and Roof Construction—Ingenuity in form handling is displayed chiefly in concreting the roof slab including the column capitals. The columns are 28 in. in diameter and the roof is a 11-in. slab thickened to 16 in. at the 8-ft. square drop panels and in the peripheral bay next to the walls. The columns are spaced 20 ft. both ways, the roof being designed for a combined

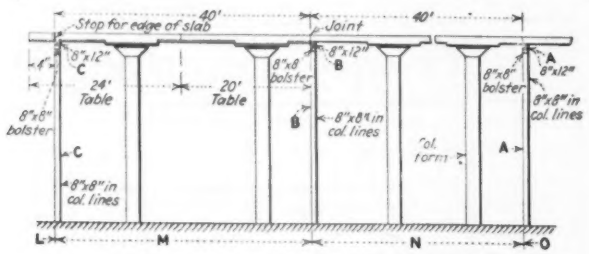


FIG. 9—DIAGRAM OF ROOF CONCRETING PROCEDURE

live and dead load of 500 lb. per sq.ft. Briefly, the procedure is to build roof and columns in 40-ft. strips across the reservoirs and at Neutaconkanut this gives a strip 400x40 ft. Concreting begins at one end of the strip and proceeds along it taking about a week to complete both columns and slabs. As the concrete gets from three to five days old, the slab forms beginning at the end where concreting started are moved out from under and set up for the succeeding strip.

The column forms are metal and are in no way unusual. The roof forms are, however, unique. They consist of 20x20-ft. and 20x24-ft. units of steel-sheeted platforms on legs—a table-like structure. A typical roof form is shown by Figs. 6 and 7. It will be noted that they are dimensioned to span between column centers. To do this and be capable of movement ahead between columns, a 4-ft. leaf on each side is hinged to drop down as in a drop-leaf table. These leaves where the columns come have circular slots for the column forms and are depressed to form the drop panel. The tables being only 16½ ft. high, have extension pieces which are bolted onto the legs so that in place for concreting they stand at the proper height from the reservoir floor. To move the tables ahead, a frame carriage, Fig. 8, riding on Ford car wheels, is run underneath, the leg extensions are unbolted and the table is lowered by screw jacks onto the carriage.

There is little novelty in the column forms. They are the regulation circular steel forms. But they have unusual height and pouring them in one operation from 1-cu.yd. bodies on motor trucks brought rather heavy strain on them. With 400 columns poured as of July 14, none had failed.

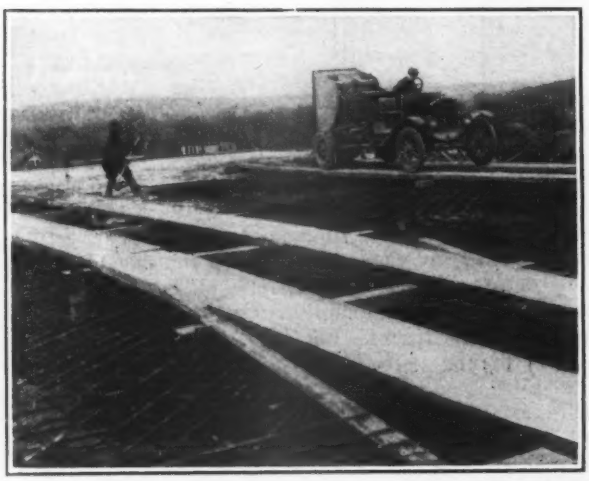


FIG. 10—MOTOR TRUCKS CONCRETING RESERVOIR ROOF

The diagram, Fig. 9, illustrates the procedure of concreting and shifting the roof slab forms. Remembering that construction advances by a succession of 40-ft. strips across the reservoir, the diagram indicates a transverse section, the arrow indicating the direction of progress. Noting that the construction joints between strips come at the middles of bays, strip *O* has been concreted, strip *N* is being concreted and strip *M* is the next in order of construction. The edge of the finished slab in strip *O* is supported by a timber beam *A* spanning between posts *A* set in the lines of the columns. The forms are under strip *N* and a similar post and beam support *B* is set where the construction joint will come. After strip *N* is 3 to 5 days old, the table forms are jacked down and the side leaves are dropped, clearing the columns and beam and posts *B* where moved ahead into strip *M*. Then, too, beam and posts *A* are taken down and erected at *C*. It has been noted that 20x20-ft. and 20x24-ft. table forms are used. The 20x24-ft. tables are kept ahead, Fig. 9, and the extra 4 ft. of top is used as a working platform.

The roof forms besides the load of concrete and reinforcing steel also carry the runways for the motor truck delivery of concrete as shown by Fig. 10. The forms as illustrated stand up well under the load of traveling trucks and of dumping in ¾-cu.yd. batches. A ramp takes the trucks from ground level onto the roof. The mixing plant is of standard type. Bank-run sand and gravel are brought to the elevator, screened at the top and chuted to separate bins.

Direction—The general contractors are Westcott & Munroe, North Attleboro, Mass., for the Longview reservoir and A. Phelps & Sons, Knoxville, Iowa, with C. E. Knowles as superintendent, for the Neutaconkanut reservoir. The subcontract for all forms is being executed by the Deslauriers Column Mould Co., Inc., New York, with E. F. Rockwood in executive charge and J. E. Wheaton, superintendent. The Barker Steel Co., Boston, Mass., has the subcontract for furnishing and placing all reinforcing steel on the Longview reservoir.

The new Providence water supply is being built under the direction of the Water Supply Board with William W. Peabody, chief engineer. J. V. Turner is resident engineer in charge of the reservoir construction.

Wrought Iron Pipe in Cathedral Masonry

In constructing St. John's Cathedral in New York City, provision has been made for concealed radiators high up in the interior of the nave and for snow melters on each of the many sections of the intricate roof. The necessary pipe, from the heating plant to these heating units, is being set in the masonry, which is in some places 12 ft. thick. Such piping must be as nearly permanent as is possible and extreme care is being used in its installation. The pipe being used is quadruple extra heavy wrought-iron pipe ranging in size from 1½ to 4 in., the 4-in. pipe having a wall nearly 1 in. thick; such thick walls were deemed necessary in view of the extra long life required. All joints in the pipe are oxy-acetylene welded, the welders working just in advance of the stone masons. The pipe is received with the ends beveled at the mill. After making any bends required, the lengths are placed in position and welded. As soon as welding is completed the pipe is coated with tar, and covered with a heavy layer of insulating material. Each section of the various lines is tested, as completed, by capping the ends and applying a hydrostatic pressure of 2,000 lb. per sq.in.

Some Aspects of New England's Greatest Flood

General Losses—Railroad, Public Utility, Highway, Municipal and Agricultural Damage—Effect of Stream Flow on Dams—Reconstruction Problems—Need for Gathering Hydrologic Data

By John W. Shaver
Assistant Editor, *Engineering News-Record*

TRADE and traffic on the streets of Burlington, Vt., appeared normal as I climbed the hill from the ferry after a cold windy hour on Lake Champlain. There was little to indicate that nearby a flashy stream had far overtopped its banks, recording a flood height never before attained. After registering at a hotel I sought Red Cross headquarters, for passes were required to enter any of the flooded valleys. Getting local transportation I drove to several points in the Winooski Valley easy of access. The first picture I got of the destruction the river had wrought was to be repeated with certain regularity for the next week. It mattered not whether the valley was that of the Winooski, Lamoille or White River, the same desolate pictures were there. Railway track with ties attached twisted into spiral ribbons, steel bridges slouching in the now languid river, abutments and piers scoured and at dangerous angles or pitched headlong into the stream, highways under mud so that their courses were lost, gaping holes in the hillsides where small streams had suddenly become torrents, taking huge bites out of railway and highway embankments, houses and barns tilted at crazy angles or, completely demolished, strewn along the highwater mark or hanging on trees, meadowlands covered with mud and sand or scoured to ledge rock, and here and there a pile of carcasses where some rendering company had salvaged the hides of drowned cattle.

Here was the Winooski, now a placid stream, that one could toss a stone across; but a mile on the other side of the valley was the tell-tale high-water mark well defined by hay and small débris caught in the trees or littering the higher pasture land. And it was less than a week since the flood had come and gone.

For a week I traversed Vermont's devastated valleys, over almost impassable roads, or walked through mud and sand. Everywhere temporary reconstruction was being pushed. People digging their houses out of the mud or salvaging what farm tools they could. Acres of drying bedding, mud spattered. Furniture standing on porches warped and weather worn. It was no time for minute examination of damage to engineering structures. People generally were too busy with personal things. The data herein set forth must then be only meager. It will take time to examine and make reports on engineering structures, but the picture given here is representative of what happened in Vermont's flashy streams.

A Great Flood—With the recession of the flood waters it becomes clear from the scanty hydraulic and hydrologic data so far available that this was by far the worst flood New England has known in modern times. Observations of those equipped to make more or less accurate measurements point to the fact that the flashy streams in western Vermont, at least, reached heights and velocities considerably beyond the flood of 1869, despite the fact that the rainfall of Nov. 2, 3 and 4, 1927, was less than that of 58 years ago, as will be seen from *Engineering News-Record* of Nov. 17, p. 796. The recent flood exceeded the former one by from 4½ to 7 ft. In fact in the Winooski Valley measurements at a point where a still earlier and apparently greater flood, that of 1830, had been recorded by a notch in a hitching post show that the present flood exceeded it by slightly more than 4 ft.

Rainfall and Runoff—Just why, with a lower rainfall, the flood of the current month was higher than the early records is not wholly clear. It may be that on the divide between Lake Champlain and the Connecticut there was a concentration of rainfall greater than indicated by any rain-gage. The point of highest record, Somerset, Vt., with 9.65 in. in less than 48 hours, is near the divide, but even higher intensities of precipitation may have prevailed over parts of the mountain ridge. At all events the stages of the mountain streams were unprecedented, not only at points where obstruction or constriction of the channel was evident but also farther up, where no such aggravating factors appear to have entered.

At Northfield there was a remarkably even continuous rain from noon Nov. 3 until midnight. During this period 5.16 in. of rain fell. The intensity of the storm reached Burlington between three and four hours later. The precipitation for this same twelve-hour period at Burlington was 3.14 in., though the heaviest precipitation at that station was recorded between the hours of 10 p.m. Nov. 3 and 10 a.m. Nov. 4, when 4.49 in. fell.

Along with these rainfall figures it is interesting to note what happened in the Winooski River at Burlington. Due to the intensive and continuous rainfall near Burlington the river rose rapidly during the day on Nov. 4 and ran for several hours near crest height which was reached at 6 p.m. It dropped 6 ft. in the next fifteen hours and from there on the recession was slow. In short it rose to its crest in 24 hours and dropped in 48. Indication of the intensity of the flood is found in the fact that the drainage area of the river at this point is less than 1,100 sq.mi. and the discharge at crest level was estimated at about 100,000 sec.-ft.

The greatest damage was done in valleys traversed by rivers rising along the Connecticut—Champlain or the Connecticut—Hudson River divides. Damage along the lower Connecticut was mostly submergence but in the upper tributaries most of the losses resulted from violence of flow. The damage in the Winooski, Lamoille and Missisquoi valleys was the greatest, although the Passumpsic, White, Otter and Hoosic valleys were badly flooded. All these rivers, but particularly the first three, were converted into streams of violent flow.

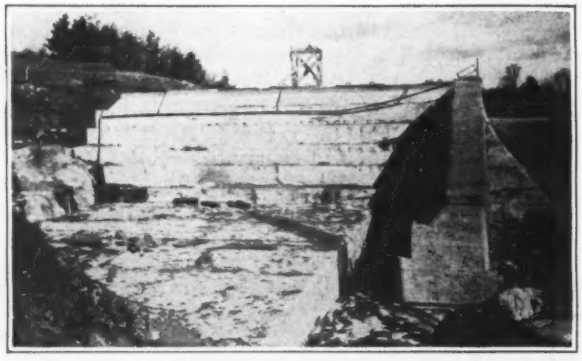
Where water was backed up above narrow defiles in the stream beds the destruction was more through submergence than violence of flow. Both the Winooski and the Lamoille valleys are successions of meadowland from a half mile to a mile wide, constricted at intervals of 15 miles or less into what in the West would be called box canyons. Débris piled in these narrow defiles backed up

the water until at places there was a difference in high water elevation above and below these temporary dams of 20 or 25 ft. From what eye-witness information is available numerous drownings resulted from the giving away of these temporary dams with the resultant rush of water. Unusual submergence above these dams resulted in extensive loss of farm buildings and livestock.

General Losses

Actual loss from the flood in Vermont and New Hampshire has been estimated by Secretary of Commerce Hoover as follows: Family loss (homes, furniture, cattle, tools and implements) between $7,000,000 and $10,000,000; railroads about $6,000,000; highways about $10,000,000 ($7,000,000 in Vermont alone); industry (Vermont alone) approximately $7,500,000. The preliminary estimates indicate that the Vermont loss is in the neighborhood of $30,000,000, and that spread over a population of less than 400,000.

Highways—Highway destruction is of remarkable proportions. The Vermont Highway Department, after a rather careful check, found 930 bridges lost, of which 105 are on federal-aid highways, 203 on state-aid roads and 538 on town roads; total value, $5,008,000. Impairment or loss of highways represent $651,000 on federal-aid roads, $1,025,000 on state-aid highways and $790,000 on town roads. Principal damage to highways consists in entire loss through scour of embankment and surfacing, or burial under sand, mud and gravel. Most of the highways affected are of gravel though on paved roads intermittent stretches have been broken up by destruction of the subgrade or washed away by the violent flow. In many places the flood eroded the stream bed to great width, encroaching on highways skirting the valleys. In places it has been necessary to crib with poles and brush cut at the site, then sand and gravel fill these cribs to put a road through for emergency travel.



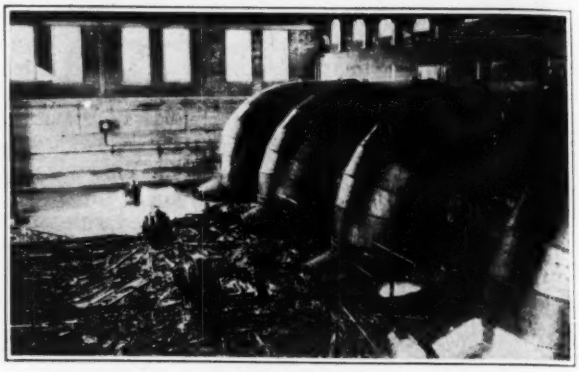
EAST ABUTMENT AND WINGWALL OF ESSEX JUNCTION DAM OF BURLINGTON LIGHT & POWER CO.

The water at crest of flood topped the dam some 5 ft., taking away the fill as shown. The west abutment was eroded and water ran around the end of the abutment. Concrete corewall now is being constructed to tie the west abutment to ledge rock.

Railroads—Loss to the railroads is in bridges, track and roadbed, although much of the steel can be salvaged, together with a few of the steel bridges. There was no uniform damage to bridges. Some were pushed over and washed downstream considerable distances. Others failed through scouring of their piers or abutments, and still others were lifted from their piers by the vertical thrust of flood waters and either dropped into the water or distorted on their seats.

Inspection of the Winooski and White River valleys indicates that the greatest roadbed damage occurred where small mountain streams passed through culverts under the track. Such streams became torrents and in many instances cut through fills as high as 75 ft., leaving the distorted track high in the air or else fallen in the hole. The Central Vermont, Rutland, Wells River and two or three small independent lines were the heaviest sufferers.

Dams—Public utility damage was confined almost entirely to the loss of dams of antiquated design, damage to



INTERIOR OF POWERHOUSE OF BURLINGTON LIGHT & POWER CO. AT ESSEX JUNCTION ON THE WINOOSKI

The high water mark reached near the top of the penstock heads. Photo shows one of the generators running. Flood waters cut off attempts to shut the plant down and this generator ran for more than two days, a great part of the time being almost completely submerged.

penstock lines and to submergence and partial loss of generating equipment. This is important in view of the fact that there was some anxiety both outside and inside the flood area as to what might happen to dams and appurtenant structures from such violent stream flow. As a matter of fact the pondage of the dams which did fail was relatively small and what water was released by dam failures had no effect on the general damage wrought. There appears to be but one dam of so-called modern design which failed, and this was put to a test which cast no reflection upon its design.

In the Winooski Valley there was offered an excellent chance to observe the effect of flood waters on a long chain of plants operated by the Montpelier and Barre Light & Power Co. This company operated plants from Peacham, on the headwaters of the Winooski, to Duxbury, about 25 miles above Burlington and 4½ miles below Waterbury. The first to be considered is Mollys Falls, just below Peacham, for it was variously rumored that that dam had failed. On the contrary the main dam at Mollys Falls was not overtopped and the only damage at this point was the uncovering of the penstock.

The Number Five plant of this company, located about four miles above Montpelier, has a concrete spillway 24 ft. high and 190 ft. long. Five feet of water went over this spillway but there was no damage to the dam itself, though the stream from the spillway underwashed the penstock piers, causing the loss of some of the penstock. A quarter of a mile downstream is the next dam which is of the same general type as Number Five plant. This dam affords a head of 65 ft. and the spillway is 165 ft. wide. Here a wingwall at right angles to the dam and 30 ft. long tipped over and water went around the

end of the dam, taking away about 300 ft. of penstock, first scouring the piers to cause the failure. Wash from a small tributary carried the penstock into the main river.

Complete failure of a timber crib dam was that at Middlesex (Number 2 plant). This dam was built more than 35 years ago. The timbers were framed but the cribs were never filled. The dam was 50 ft. high with a spillway 180 ft. long. About 20 ft. of water went over this dam at the crest of the flood and after the flood had subsided there was not a splinter of the dam remaining. Little damage was done to the powerhouse, only one of the draft tubes being taken out; the generators didn't even get wet. Redevelopment had been planned at this site for several years, but money was lacking and it was kept in service. Last summer the dam bulged about 3 ft. and settled 30 in. and it had been held to be in a dangerous condition. Partial failure of a log-crib dam was recorded near the mouth of the Mad River. About half of this structure was carried away. This dam, which was built in 1907, was 35 ft. high. The flood wrecked the powerhouse and took out a highway bridge immediately below the dam. About 8 ft. of water went over the crest of the dam before it failed.

A timber dam in this chain which did not fail was at a plant four and one-half miles below Waterbury (about 25 miles above Burlington). This dam was built as a rock-filled timber-crib structure. Several years ago it had been given a facing of granite blocks laid up in mortar. The dam is about 55 ft. high and has a spillway section 196 ft. long. It was estimated that 14 ft. of water passed over the spillway at flood crest.

Two miles up the Mad River from the mouth was a concrete overfall dam of ogee section 51 ft. high with a wing wall about 30 ft. long. The water went over the top of the spillway about 12 ft. deep and sheared off the wing wall at spillway crest level. Approximately 300 ft. of penstock was destroyed and the generator was under water that at flood crest attained a height of 10 ft.

The dams mentioned above are the only dams on the Winooski used by utility companies except the two at plants farther down the river operated by the Burlington Power & Light Corp. The dams at the Essex Junction (near Burlington) plant of this company was undamaged, though it was estimated at least 5 ft. of water went over the main dam at the height of the flood. The water poured over the triangular section between the wing wall and the abutment at the east end, taking out all the fill. Here it will be necessary only to replace the fill. At the west abutment, however, the water eroded the bank and ran around the end. As this abutment did not run to ledge rock it will be necessary to construct a corewall from abutment to rock as the basis for a fill. The water over the spillway section, which is on curve, at the height of flow was estimated at about 17 ft. The powerhouse was submerged to within a foot or two of the penstock head, as will be seen in an accompanying figure.

Above the American Woolen Co. plant on the Winooski at Burlington there is an old log-crib dam whose age is variously estimated at from 75 to 100 years. No record is available of its construction plan. Several hundred feet below this dam is a concrete apron across a narrow rocky defile in the river. The old dam held despite the fact that about 20 ft. of water went over it at the crest for a period of several hours. Small houses on the bank were taken away but the dam stood, as did the concrete apron downstream.

Power Storage and Flood Control

Two outstanding examples of the effects of power storage on stream control are had in the experiences met with on East Creek near Rutland and on the Deerfield River in the mid-Connecticut watershed. A less important example is to be found in the performance of Second and First Lake reservoirs in northern New Hampshire.

East Creek—On East Creek (a tributary of Otter Creek and emptying into that stream near Rutland) the Vermont Hydro-Electric Corp. had four dams which ponded the entire head in the creek. On this creek were, in order, the Chittenden dam, East Pittsford, Glen and the Patch plant. The equalizing effect of this 100 per cent development was so great that the stream was practically controlled, the only damage being partial failure to the Glen dam through diversion of a tributary. Chittenden spilled but little, the drawdown having been heavy during the summer and the reservoir was only about 70 per cent filled when the flood came. Mendon Creek entered East Creek just below the powerhouse of the East Pittsford plant before the storm, but its diversion brought it out into East Creek during the flood above the powerhouse. The tailrace was filled with hardheads and the débris piled high around the powerhouse. This condition affected materially, it was maintained by the general

WHAT STREAM DIVERSION DID IN CAVENDISH, VT.

Stream overtopped its banks and took straight course between two 150-ft. knolls. Estimates place material moved by this diversion at about 1,500,000 cu.yd. Knoll at the left shows old highway grade at about midheight. Highway also shows at left of three white trees. A small waterway had been led under the highway grade through pipe. This waterway, greatly supplemented by the main stream which left its banks did the damage shown.

manager of the Vermont company, the flow at the Glen station, where a portion of the dam was destroyed. The Glen dam is an earth dam with an 18-in. concrete corewall and is about 1,200 ft. long. The spillway is 80 ft. long and it is 5 ft. from the top of the spillway to the crest of the dam. Additional storage was provided by 30-in. flashboards built in about 10-ft. sections. At the time of the flood all of the seven sections of flashboards were in. Employees of the corporation were sent to the dam, when the waters began to appear dangerous, to remove the flashboards if it was thought necessary. After two sections had been removed the water in the pond receded about 9 in. and it was thought that with this additional spilling the flood could be controlled. Those watching left the dam. When observers on the lower river noticed a rapid rise in the river toward noon operators of the plant were again sent to the dam but they got there just in time to see a section of it go out. The drain dam was overtopped and the earth fill had been washed away above and below the dam. With the earth gone a section of the corewall more than 50 ft. in length broke off a few feet above the spread footing.

Deerfield River—Probably the best indication of what storage for power uses will do toward flood control is found on the Deerfield River, at the dams operated by the New England Power Co. The development on this river include the Somerset (1913), Searsburg (1922), Davis Bridge (1924), Sherman (1926), No. 5 (1915), No. 4 (1912), No. 3 (1912) and No. 2 (put into operation in 1912). The total head on these plants is 1,130 ft. The drainage area at Somerset is 30 sq.mi. and at Davis Bridge 154, with the total drainage area for the basin of 500 sq.mi. at plant No. 2. At the time of the flood Somerset reservoir was only about two-thirds filled. During the storm it collected 2.972 billion gal. and had a reserve capacity after the storm of 3.150 billion gal. Its total capacity is 20 billion gal. Davis Bridge reservoir, with a total capacity of 37.5 billion gal., collected 14.5 billion gal. and still had a reserve capacity of 10 billion gal. In other words Somerset would have absorbed twice the rainfall it did and Davis Bridge reservoir would have been able to care for five-sevenths more than it collected.

Searsburg reservoir had just been drained for inspection but when the flood came it was immediately put back into service. The Sherman dam, an earth dam with a concrete spillway and a drainage area of 234 sq.mi., had 8 ft. of water over the spillway, as did the dam at plant No. 5. At Shelburne Falls, plants 2, 3 and 4 (concrete spillway dams) passed 13.7 ft., 8.1 ft. and 12.6 ft., respectively, over their crests.

New Hampshire Lakes—In upper New Hampshire on the Connecticut watershed the New England Power Co. had developments at Second Lake and First Lake. After collecting 2.973 billion gal. Second Lake began to spill. First Lake, farther south, collected 3.655 billion gal. and then had a reserve capacity of 6.657 billion gal. Second Lake has a drainage area of 41.5 sq.mi. and First Lake 39.9, or a total for the two of 81.4 sq.mi. The first damage of any importance on the upper river is reported to have been met south of the Passumpsic.

The only other plant which the New England Power Co. had on the Connecticut was at Bellows Falls, where a large dam is under construction. Here the company lost part of a cofferdam and two derricks and some small miscellaneous equipment. The river, however, at its height followed an underpass under the railroad and took out a section of earth back of the abutments of the highway and railroad bridges some 100 ft. wide and several hundred feet long, digging a new channel. This has since been cut off and the river diverted to its old channel. Though the river dug this channel landward from the abutments of the bridges and left them without approaches, they did not fail.

Municipal Losses — Damage to cities was mainly through submergence and deposit of silt and sand. A careful checkup on the part of the Vermont State Department of Health revealed the fact that only Waterbury needed speedy relief. Where there was doubt as to the purity of water supplies chlorine was applied or the dosage increased. In general sewerage facilities were not impaired. In few towns affected were there combined systems, the storm water flow being usually disposed of by surface means. Submergence and deposition of silt and sand caused heavy damage in cities both to private homes and to business establishments.

In considering municipal damage the situation at Montpelier may be taken up in some detail, partly because this was one of the worst hit cities of all. It presents a striking example of what lack of proper stream control may produce.

At the center of the city the north branch of the Winooski enters the main river practically at right angles. One of the two principal business arteries passes over the stream, which at that point is confined to a channel about 40 ft. wide. Less than 2,000 ft. upstream from this bridge is a small power dam with a head of about 12 ft. It is a concrete ogee dam with 3½-ft. headwalls running upstream. The wall on the north side of the stream is less than 100 ft. long and at its end is a short wingwall with an unprotected shore end. At the south side of the dam is the intake. The stream at the dam is not more than 85 ft. wide. Between State St. and the dam (about 2,000 ft.) were five bridges. Only two of these are left. When the water rose it first dammed the stream with débris at State St. bridge, then entirely filled the channel. finally lifting out the heavy single-span steel bridges and floating them downstream. At the flood crest accurate measurements indicate that the wing wall of the dam was overtopped by about 5½ ft. and the dam itself by about 9 ft. The main channel of the flood waters was diverted by the wreckage that had piled against the abutment of one of the steel spans lodged against the upper bridge that remained. Evidence that this happened is had from examination of the corners of buildings in the path of the current and by the oral testimony of persons who watched the flood. The stream channel had been held to a capacity corresponding to little beyond its normal flow, and had not even been straightened, although it overtops its banks frequently in times of spring freshets. It was the constriction of this stream that did the most damage in Montpelier.

Stream Diversions—Two other instances wherein streams left their normal channels and wrought heavy damage are worth note. At Cavendish, Vt., the Black River left its banks above a dam owned by the Vermont Hydro-Electric Corp. and followed a straighter course between two knolls about 150 ft. high. The power company had diverted a small watercourse that followed around the toe of one of these knolls from the main stream by putting in a cutoff wall of steel sheetpiling, reversing the flow and leading the water between the knolls at grade. When the main stream left its banks

it joined the flow of this watercourse and cut the earth from between the knolls, taking away a volume of material estimated at 1,500,000 cu.yd. and spreading it out on the marsh and meadowlands below.

The other stream diversion, which is analogous to that of North Branch at Montpelier, was at Proctor, Vt. Here Otter Creek runs in a constricted channel to the dam of the Vermont Marble Co. At the dam, where the water takes a sheer drop of around 90 ft., the stream width is about 50 ft. and its depth comparatively shallow. A rough estimate of its normal flow would be about 500 sec.-ft. The Rutland R.R. parallels this stream for some distance above the dam and at the station of Proctor runs through a rock cut about 30 ft. deep on a single track. When the flood waters filled the natural channel they took to the railroad cut, went through the yards of the Vermont Marble Co., followed through a second rock cut and with a head of more than 100 ft. dropped to the valley below. It is estimated that about 500,000 cu.yd. of material were scoured from the side of the hill.

Agricultural Losses—Damage to agricultural lands has been considerable, although it is impossible to place an estimate thereon. In none of the valleys affected were the losses on this score worse than in that of the Winooski. Where the current was swift bottom lands were eroded to ledge rock or gravel beds. Where backwater above temporary dams occurred the silt carried to those areas was deposited from 6 in. to 6 ft. deep. Where the deposit was of mud the farmer is apt to be benefited, but in more than half the cases the deposit was of river sand and gravel, almost impossible to remove.

Loss of livestock and other animals is relatively small. At a meeting in Montpelier Nov. 17 the commissioner of agriculture reported a loss of 1,700 dairy cows, less than 100 horses and less than 100 sheep and pigs. The tangible loss to livestock was placed at $1,500,000. The loss of houses was reported at the same meeting as being 269, with 1,000 badly damaged, for Vermont alone. Loss of barns and damage to others is not much less.

Reconstruction—As to temporary reconstruction, the needs of transportation must come first. Vermont, itself, depends almost entirely on two railroad systems for its subsistence. Hardly more than two weeks remain before a severe Vermont winter may set in and in that time it is hoped to have some continuous means of rail communication in operation. The two lines most affected have the advantage of being able to call on larger capital for their rehabilitation, but there is at least one independent line which serves a large number of small communities that it appears must go slow in reconstruction, if it ever opens its lines again. But on the Rutland and the Central Vermont large camps are established for reconstruction. The Central Vermont alone has approximately 1,800 men scattered through the Winooski Valley from Burlington to White River Junction "putting daylight" under the rails so that ballasting will not be impossible even in freezing weather. The immediate railroad rehabilitation, must, therefore, be more or less permanent, and the bridges are the controlling factors.

While the railroads are not functioning freight transportation has been transferred to the highways. They can be put in quick repair, though maintenance forces must be ever on the alert because of the increased demands made upon the highways. Reconstruction of bridges and the provision of temporary river crossings and roadbed are the chief concern of the state and towns. Due to the topography main highways follow the valleys that have been devastated, so the reconstruction work is enormous. Roadside pits for sand and gravel can be opened at almost any place but for temporary work only. More permanent work demands graded and washed materials; time is too short now for these considerations. The main objective is to open the roads, construct temporary stream crossings that may or may not go out with the spring freshets, and depend on the freezing weather, once roads are opened, to hold them for winter travel.

So far as permanent highway reconstruction is concerned there must be a revision of the bases for design of both roadbed and bridges. It is apparent that heretofore structures have not been designed for the ultimate in flood probabilities. Many culverts of recent construction have been ripped out by the mad waters of storm swollen streams.

1927 FLOOD DISCHARGES COMPARED TO HIGHEST PREVIOUS FLOOD

River	Station	Date of previous high and Gage Height	Highest Before 1927 Sec.-Ft.	Discharge Nov. 1927 Flood Sec.-Ft.
Connecticut	First Conn. Lake near Pittsburgh	.....	3,870	(2.3)
	South Newbury, Vt.	May 1–23 30.65	43,600	(35.4) 48,300
	White River Jct.	Apr. 12–22 26.8	88,500	(33.84) 132,000
	Sunderland	Mch. 28–13 30.7	108,000	(34.08) 122,000
	Vernon	.....	.....	(123.7)
	Bellows Falls	.....	.....	152,000 (25.7)
White River	West Hartford	Mch. 27–13 18.9	30,000	(29.1)
Deerfield	Charlemont	July 8–15 15.7	45,000	(Nov. 3) (13.38) 33,600
Westfield	Westfield	..... 22.13	24,500	(Nov. 5) (25.41) 36,800
Westfield Middle Br.	Gloss Heights	July 8–15 7.33	4,500	(Nov. 3) (8.22)
Pemigewasset	Plymouth (Sta. went out)	Apr. 29–23 18.17	22,400	(27.4) 37,900
Merrimack	Franklin Jct.	Apr. 30–23 23.5	41,000	(Nov. 4) (30.85)
Smith River	Bristol	Mch. 29–25 4.94	1,660	(Nov. 4) (5.1)
Ashuelot	Hinsdale	Mch. 29–20 9.98	8,940	(Nov. 5) (13.8)

Note: 1927 gage heights (in parentheses) are those recorded by the U. S. G. S. Discharge figures for 1927 are approximated only.

Beyond the damage that has been done and the reconstruction plans that are under way and those which are still to be determined, there remains the problem of how best to obtain data on this flood that will lead to the formulation of engineering principles which may obviate the recurrence of the devastation that followed the flood of Nov. 3, 4 and 5. The U.S. Geological Survey has sent men from its Boston office to get the data while they are fresh. The Corps of Engineers is planning surveys of the flooded areas, and the Bureau of Public Roads has a party in the field gathering flood data.

Stream flow data on this flood are scarce. The U.S. Geological Survey, through lack of co-operative funds, ended stream gaging on the Winooski, Lamoille and Missisquoi in 1923. In a table herewith are given all the figures available for the flood area on stream discharge during the late flood. Their insufficiency indicates the need for greater attention to the gathering of such information.

From Job and Office

Hints That Cut Cost and Time for the Contractor and Engineer

Setting Stone Work of Arlington Memorial Bridge

By J. M. Robbins
Engineer, H. P. Converse Co., Washington, D. C.

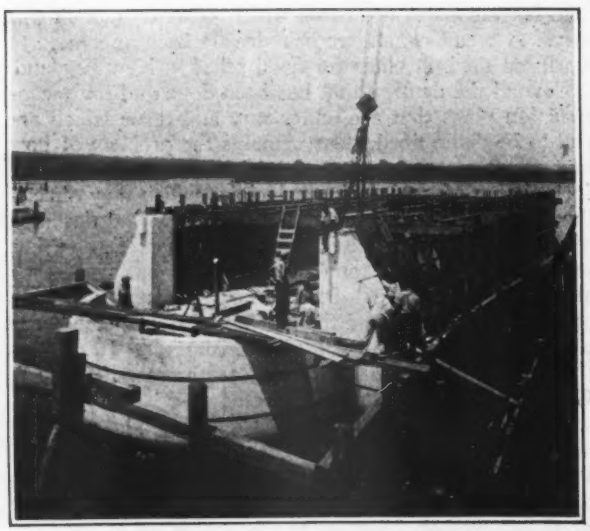
THE construction of the Arlington Memorial Bridge, across the Potomac River at Washington, D. C., presents a number of features unusual in bridgework. Among them is the very high order of workmanship employed in cutting and setting the granite facing of the structure.

To give the structure the desired monumental appearance the granite facing is being cut and placed in accordance with the best practice used in ornamental building work. The specifications for furnishing the stone state that "the class of work usually found on bridges will not be acceptable."

The piers and abutments, now being constructed by the H. P. Converse Co., of Boston, are faced with Stone Mountain granite from an elevation 3 ft. below mean low water to the springing line of the arches. All exposed surfaces are specified to be four-cut, bush hammered throughout. Joints, horizontal and vertical, are ¼ in. in thickness.

In setting the stone, after the bridge and pier axes have been accurately located, the granite lines, centers of circular cutwater curves and the corner stones themselves are put in with transit and tape. For this work an instrument with vernier reading to 20 sec. and standardized tapes with the usual tension and temperature apparatus necessary for precise measurement have been used.

Benchmarks are established on each pier and a level is used throughout the work of stone setting, grades being taken at each end of each stone and the stones picked up and reset as often as necessary to get them bedded at the required grade. All stones are required to be within 0.005 of a foot of true line and grade.

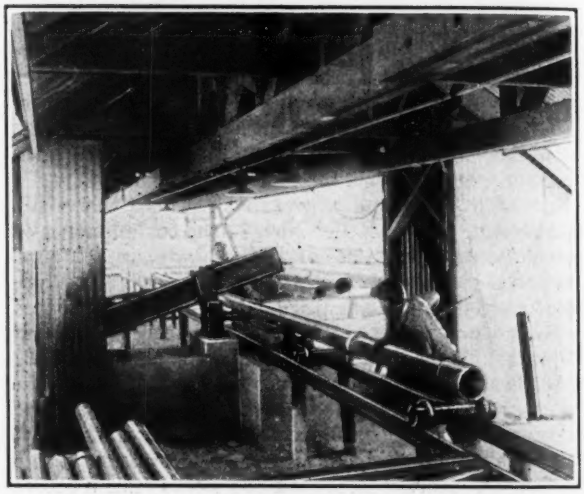


SETTING GRANITE FACING AT ARLINGTON BRIDGE

The work on the superstructure will be similar in character to that on the foundations though the greater comparative difficulty in setting the irregularly shaped voussoirs and the slightly sloping courses above will undoubtedly necessitate even greater care than has been required to give the piers the beautiful and monumental appearance desired.

Power-Operated Pipe-Straightening Device Used in Oil Fields

USED pipe is perhaps the largest item among materials that come to the equipment yards of the Standard Oil Co. near Bakersfield, Calif., for reconditioning before being stocked for further use. One of the first requirements is to straighten bends and kinks in such



PNEUMATIC STRAIGHTENER FOR RECONDITIONING OIL PIPE

pipe, and to facilitate this work the pipe-straightening machine illustrated here has been designed and built by the local engineering organization.

Fundamentally the scheme is to place the pipe in positions for straightening beneath a steel lever arm operated by compressed air and mounted in a heavy concrete setting. The arm is controlled by a three-way valve placed within convenient reach of one of the two men that constitute the operating crew. The downward pressure of the lever arm straightens the pipe which is meantime steadied in position by chain tongs held by the crew.

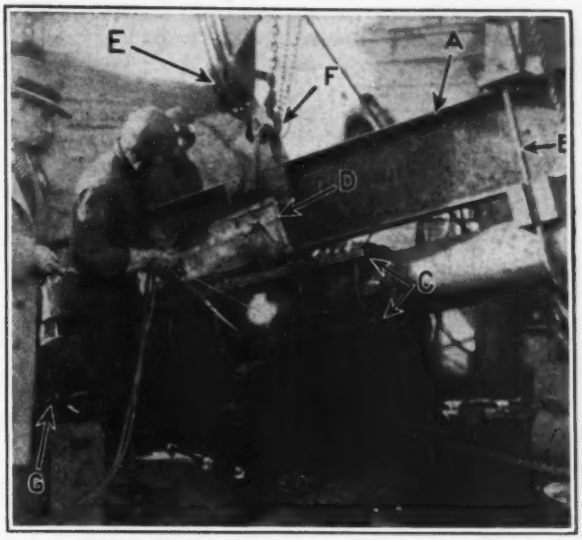
Flanged rollers on a track made of rails are used to roll the pipe under the lever arm, and at the points of support for the actual bending spools with deep flanges and of sizes suited to the various pipe diameters are provided. The lever arm consists of two heavy steel channels bolted together and fitted with a block having a curved surface so as to distribute pressure on the pipe. Beneath the point where the lever is applied to the pipe a concrete pedestal limits the downward travel. With this device pipe up to 10¾ in. outside diameter and with a thickness of ½ in. has been satisfactorily straightened.

Difficulties Met in Welding River Crossing of Pipe Line

IN CROSSING the Mississippi River with a gas pipe line in order to obtain petroleum refinery still fractions from a plant on the opposite side, a gas company recently encountered difficulties because of the swiftness of the current and presence of ice floes which considerably complicated the construction.

The line, being oxwelded for its entire length, was a combination of the following sizes and lengths: 15 miles of 12-in. pipe, 10 miles of 10-in., about 8 miles of 6- and 8-in., and 4 or 5 miles of 6-in., in addition to the actual river crossing which consisted of two 10-in. extra heavy lines.

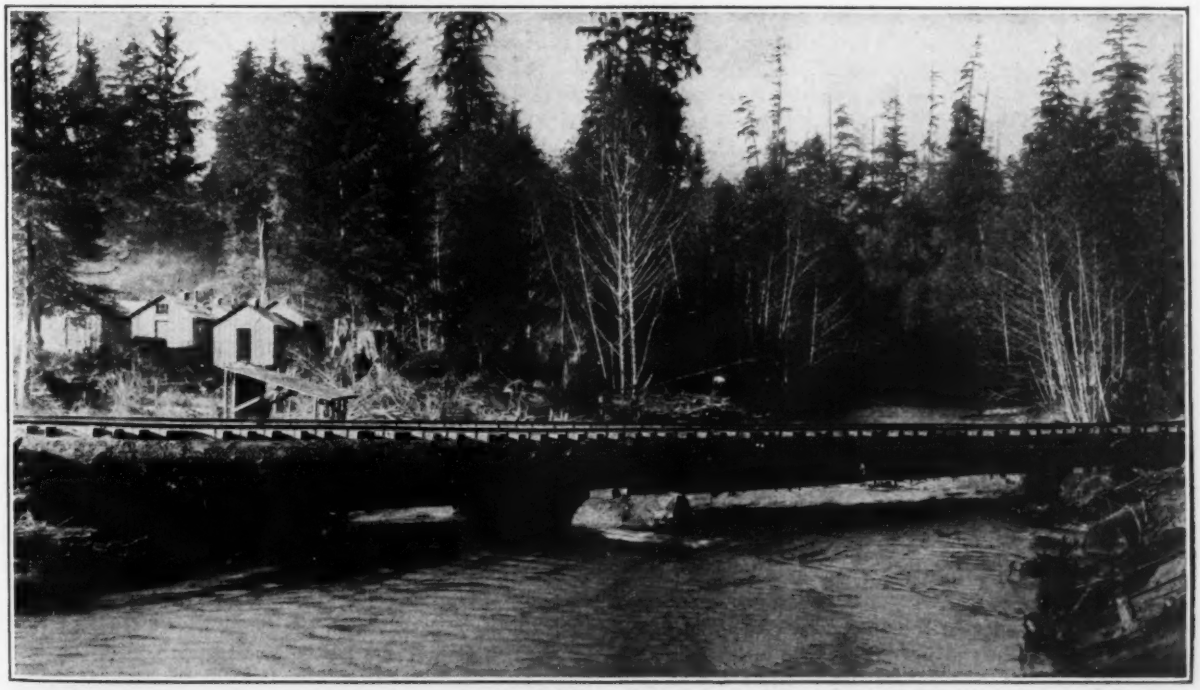
At the river crossing, it was decided that all welding should be done from a barge properly equipped with steam winches. The barge was of steel construction, measuring 130 ft. in length and 30 ft. in width. Before operations were started, a sufficient number of pipe lengths was stored on the barge, together with the proper amount of oxygen and acetylene. Pipe used for this job weighed 54 lb. per ft. and was delivered in average 36-ft. lengths. In order to maintain the barge in proper position and carry it across the river, there were dropped on the river bottom at equal distances between the banks three anchors made of concrete blocks 4½ by 6 ft. in section, with a 4-in. diameter steel ring of 1½-in. material cast in the top of each anchor. To these three anchors, placed about 500 ft. north of the river crossing, three ¾-in. wire lines were extended from the barge, passing through sheaves on the front end of the barge to the steam winches. Whenever it was necessary to move the barge, slack was taken up on whatever line it was most desirable



DETAIL VIEW OF ONE OF THE EARLY WELDS

A—A 30-ft. length of 16-in. channel held pipe in alignment. B—U-bolt used to draw pipe against block on under side of channel. C—Two sections of 3-section river clamp being tried for holding pipe ends while welding. This clamp was found unsatisfactory as it did not expose the joints sufficiently. A rectangular frame of steel with straight bolts was substituted. D—Asbestos cloth prevents warping of channel. E—Tackle for raising or lowering assembly with steel winch. F—Hook from chain hoist used to assist in handling channel clamp. G—Collar-type clamp used to hold pipe to barge by means of cable and turnbuckle fastened to stanchion on opposite side of barge.

Temporary Logging Trestle Made of Douglas Fir Logs



TWO Douglas fir logs with a diameter of about 5 ft. and a length of approximately 100 ft. placed side by side formed the river crossing of a logging railway in Clatsop County, Oregon. A couple of fir trees in the woods close by were felled, trimmed and dragged into position across the stream, which is the Lewis and Clark River.

Despite its makeshif nature, the bridge is serving its purpose adequately, easily supporting the heavily loaded trains of logs, which pass over it daily.

to use to pull the barge into its proper position. While welding was going on near the shore end, the shore lines alone were employed.

Account was taken of the fact that because of the swift current and the movement of silt, had the line been laid straight across the river it would have arched in the direction of flow, putting it at all times in tension. To overcome this, the line was arched upstream to put it under compression. The distance across the river from water's edge to water's edge where the line was installed is approximately 1,300 ft., but in this distance about 1,500 ft. of pipe were used.

In rigging up for the handling of the pipe, an overhead gantry was erected just forward of the center line of the barge and covering its width. The uprights were of 6x8-in. timbers laced with 2x6-in. pieces. The top cross members were of heavy timbers and from them blocks and tackle with which to handle the pipe were suspended. All of these lines with the exception of one chain crane hoist, were operated from the winches.

To hold the pipe in alignment for welding, a 16-in. channel 30 ft. long was used. Four blocks were spaced equally along its length, the under side of each block being cut to a radius conforming to the outside diameter of the pipe. Pipe was placed under these blocks and drawn up tight with U-bolts which fitted around the pipe and up over the top of the channel.

Material from which this article is written was taken from the October issue of "Oxy-Acetylene Tips."

From Job and Office

Hints That Cut Cost and Time

Nomograph for Safe Load on Piles

WHERE the loading of piles for determining the load which starts the pile to moving is not possible, the method generally employed is based upon the resistance to driving. The equation used is the *Engineering News* formula $L = \frac{2Wh}{S+1}$ where L is the safe load on the pile, W is the weight of the hammer used in driving, both of these in pounds, h is the fall of the hammer in feet on the last blow, and S is the penetration produced by the last blow, in inches.

In using the accompanying nomograph for solving this equation, lay a straightedge from the scale value of the weight of hammer to that of the distance of fall, and note the intersection with the blank axis. Connect this point then with the scale value for penetration on last blow, and read safe load.

Where the known quantities, except penetration, lie beyond the limits of the chart, solution may be obtained by multiplying the quantities by powers of ten. Thus, if the hammer weight were greater than the scale

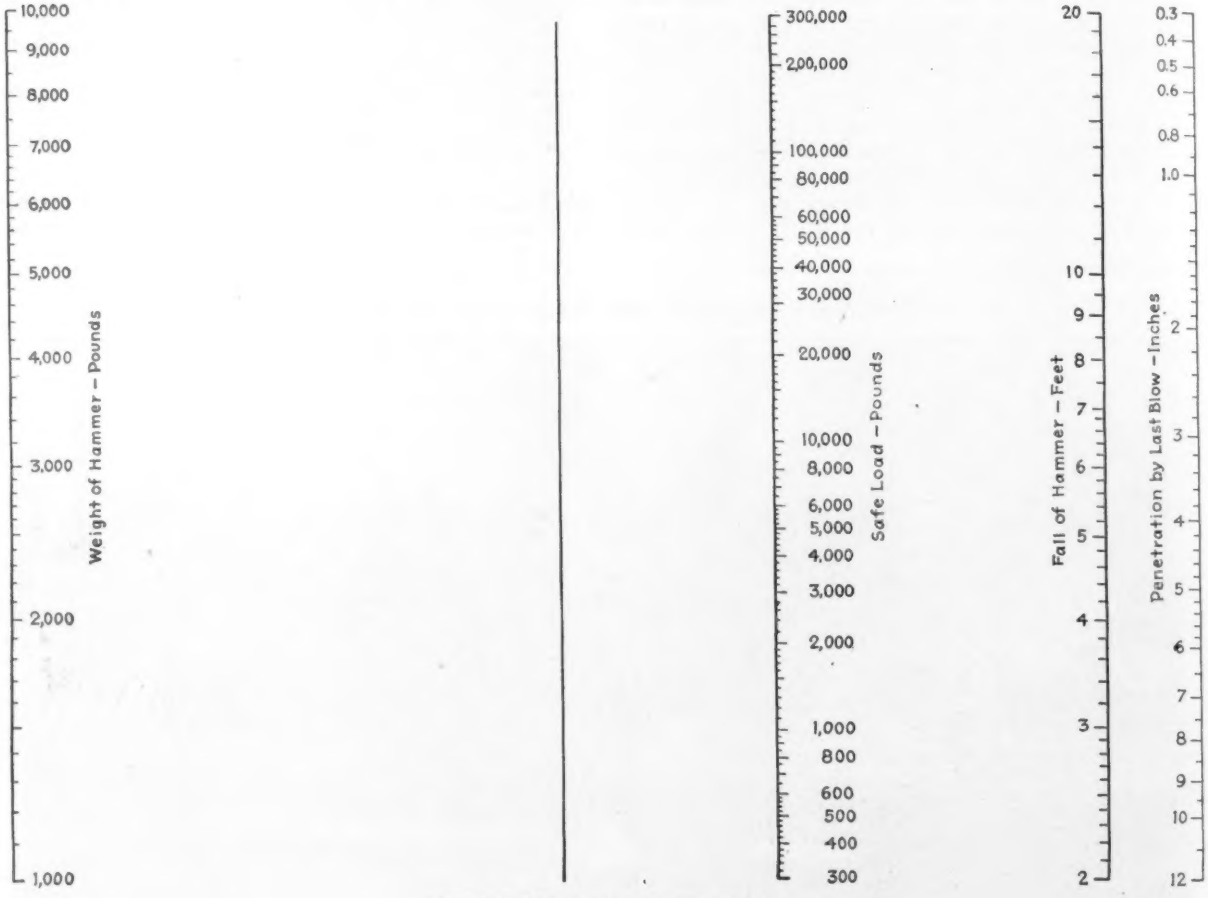


CHART FOR READING PILE LOADS

From Job and Office

For Contractor and Engineer

values, multiply it by one-tenth, remembering to multiply the safe load found by ten. Hammer fall may be treated in the same way. A factor of safety of six has been assumed so when any other is to be used, multiply the result obtained from the chart by six and divide by the desired factor.

Shellac Increases Life of Working Drawings

WORKING drawings of such construction features as a power house floor plan with a great deal of detail necessitating extensive use of blueprints, are often mounted on a wood panel to which the print is fastened by means of light wood strips tacked on around the border. When mounted in this way the life of the blueprint can be very materially lengthened by coating its surface with shellac. The shellac decreases the likelihood of making the lettering illegible with finger marks or soiling due to other causes.

Girder Weighing 103 Tons Moved Through Los Angeles Street to Theater Site

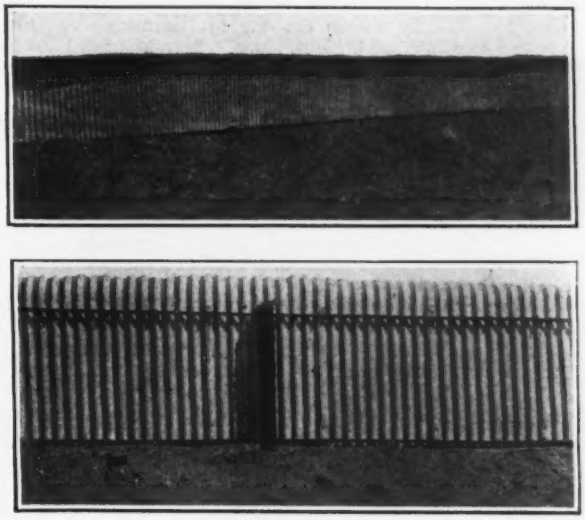
IN ORDER to afford a clear unobstructed view from any point on the lower floor of the United Artists' Theater, Los Angeles, the balconies above are carried on steel spanning the entire width of the auditorium. The main theater balcony support consists of a double-web plate and angle girder, approximately 100 ft. long and carrying seven cantilever trusses and the mezzanine below.

The girder was fabricated in the shops of the Baker Iron Works and was moved to the building site by means of moving dollies, traveling on a total of 44 wheels. The move was accomplished between the hours of 1 a.m. and 5 a.m. so that chances of tie-up in traffic would be obviated. The girder is 3 ft. wide and 7 ft. high, and weighs 103 tons. Fifty-five hundred rivets were used in its assembly.

Plans for the theater were prepared by Howard C. Crane and Walker & Eisen, architects, and the structural steel was fabricated and erected by the Baker Iron Works.

Coping on Oil Reservoir Fire Walls Turns Back Boil-Over Wave

BECAUSE crude petroleum and fuel oils are liable to boil over while burning, containers in which these products are stored are surrounded by fire walls to prevent the spread of burning fluid in case of fire. The most important function of such a fire wall may be to withstand the single wave of oil thrown out by the "boil-over." To meet this requirement, H. H. Hall, chief engineer of the Standard Oil Co. of California, has devised a curved metal coping with which to surmount earth embankments thrown up around reservoirs. Typical construction of such a coping is shown in the accompanying pictures.



INNER FACE OF OIL FIRE WALL COPING
Top of corrugated iron coping is curved so as to throw advancing wave back on itself.

METHOD OF SUPPORTING THE COPING
Corrugated sheets are wired to two runs of horizontal pipe which in turn are backed by vertical pipes set as posts.

MOVING 103-TON, 100-FT. THEATER GIRDER ON LOS ANGELES STREET

Letters to the Editor

A Forum for Discussion of Views of Engineers and Contractors

City Toll Bridges in Richmond

Sir—Your editorial "City Toll Bridges," Oct. 6, 1927, p. 533, states that a bridge project in New York is the first proposal for a private toll bridge within a city for many decades. Wholly within the city of Richmond, Va., there are three private toll bridges, namely, Marshall St., First St., and Fifth St. viaducts. They are all owned by the Virginia Light & Power Co. and connect different parts of the city across ravines.

P. K. SCHUYLER,
Associate Highway Bridge Engineer,
Bureau of Public Roads.

Washington, D. C.,
Oct. 28, 1927.

Another Pavement Crown Formula

Sir—In recent issues of *Engineering News-Record*, there have been some interesting pavement cross-section formulas. The one by L. J. Hathaway, Jr. (Sept. 15, 1927, p. 443), $y = x^{3/2}$ used in New Bedford, Mass., gives results nearly the same as those found by the method of "second differences," which I have used. This method permits the use of any desired drop at the first point from crown point toward the gutter. For the amount of the crown, I have used a modification of Rosewater's formula, $C = \frac{W}{2{,}000}(25 - P)$, where C is the crown in feet, W is the width of the pavement in feet and P is the percentage of the grade of the street. The following gives the values of the offsets from the horizontal line through the crown point to the finished surface, for four equal spaces between the crown point and the gutter. Width of the pavement is 36 ft., grade 4 per cent, and crown is 0.378 ft., or 4.5 + in. Using y_1, y_2, y_3 and y_4 as the successive offsets and assuming y_1 to be 0.6 in., the second difference, d_2, equals $\frac{y_4 - 4y_1}{6}$, y_4 being the crown.

Then $d_2 = \frac{4.5 - 2.4}{6} = 0.35$ in.

$$y_2 = y_1 + (y_1 - 0) + d_2 = 1.55 \text{ in.},$$
$$y_3 = y_2 + (y_2 - y_1) + d_2 = 2.85 \text{ in.}$$

and as a check $y_4 = y_3 + (y_3 - y_2) + d_2 = 4.5$ in.

E. R. CARY,
Professor of Highways,
Rensselaer Polytechnic Institute.

Troy, N. Y.
Sept. 24, 1927.

Labor Unions and Their "Moral Equivalent"

Sir—We wish to commend the spirit and the sound thinking shown in the letter of J. P. J. Williams on p. 724 of *Engineering News-Record* of Nov. 3, 1927.

If the professional engineer is to be anything more than the mere product of "the survival of the fittest" (not by any means the finest), he must organize himself into the moral equivalent of a strong labor union. All established civil professions which are financially prosperous, employers and employees, have done so: doctors, lawyers, architects, merchants, manufacturers and all conceivable branches of manual labor.

In order to form a strong union and to secure the benefits therefrom, the individual must surrender certain rights and undergo a certain continuous expense. The union must be able to enforce the contracts it makes with complete authority over its own members if it is to have the respect, prestige and power necessary to secure and maintain the "rights" sought. It is not necessary to affiliate with a body of labor having dissimilar interests and a dissimilar outlook. It is necessary that all engineers, who are recognized as legitimate competitors or rivals in a particular field, should agree in some manner that it is binding upon them to take certain steps to protect their legitimate and proper interests. Where this is done fairly and honorably no body of outside engineers will trespass—a thing which is foreign to the tradition and the ethics of the engineering profession.

EDWARD M. CRAIG, JR.,
Bureau of Water Supply.

New York, N. Y.,
Nov. 4, 1927.

Am. Soc. C.E.—Ages and Foreign Members

Sir—The letter from Lewis D. Rights on "American Society of Civil Engineers Admissions" in your issue of Sept. 8, 1927, p. 404, raises a lively issue in which the dignity and prestige of society membership are involved.

The following recent summary of membership in the British Institution of Civil Engineers, a very venerable one of its kind, may be compared with that of the Am. Soc. C.E. with a view to establishing whether or not Mr. Rights is right in complaining that the proposed "change of the age of admission of members and the lengthening of experience of associate members would be an unnecessary move toward conservatism."

Inst. C. E. (London) Enumeration July 1, 1927

Grade of Member	No.	Per cent of total
Hon. members	16	.....
Members	2,302	23
Associate members	5,994	60
Associates	82	.....
Students	1,672	17
Fellows	.....	.....
Total	10,066	

Am. Soc. C. E. Enumeration July 5, 1927

Grade of Member	No.	Per cent of total
Hon. members	14	.....
Members	5,315	43
Associate members	5,624	45
Affiliates	145	.....
Juniors	1,281	10
Fellows	8	.....
Total	12,387	

The writer would draw the following conclusions from the above table of memberships in the two societies:

(a) The British are 43/23 or 1.9 times as conservative as Americans in granting full membership, and 17/10 or 1.7 times as conservative in transferring students (a grade somewhat equivalent to that of junior in the Am. Soc. C.E.) to the grade of associate member.

(b) While nearly every associate member of the Am. Soc. C.E. succeeds sooner or later to full membership, barely two out of every five associate members of the British Institution of Civil Engineers may hope to receive the honor of full membership.

The writer feels strongly that the time for revising the constitution of the Am. Soc. C.E., so as to make the corporate membership a more covetable honor, has been long overdue. In his opinion, the minimum ages for admission of members and associate members should be raised from 30 and 25 respectively to 33 and 27 years respectively, with corresponding increases in experience in responsible capacity; full membership should be denied to all excepting those who have made some original contribution to engineering science, and acquired a considerable degree of eminence in the profession.

In the case of applicants from foreign countries, the recent decision of the board to limit admission only to those possessing membership in the engineering societies of their respective countries, while judicious from the viewpoint of the Am. Soc. C.E., in so far as it throws the responsibility of right selection on others, involves an unnecessary pecuniary burden on the purse of those aspiring to enter the American society. The same end could be attained by appointing honorary committees composed of two or three senior members of the Am. Soc. C.E., practicing in the various countries abroad, to whom such applications should be referred for opinion and evaluation of the applicants' standing, in terms of the society's requirements.

H. J. AJWANI,
A.M.I.E. (Ind.), Jun. Am. Soc. C.E.
Assistant Engineer, Lloyd Barrage Scheme.

Sukkur, Sind, India,
October, 1927.

News of the Week

Current Events in the Civil Engineering and Contracting Fields

See Difficulties for Sole Federal Control of Mississippi Plans

Legal Obstacles and Reluctance of States to Grant Rights Cited at Flood Hearings

(*Washington Correspondence*)

FLOOD control hearings before the Flood Control Committee of the House of Representatives, which have been in progress in Washington since Nov. 7, have brought out various difficulties in the path of sole federal responsibility for the control of the Mississippi river. While numerous witnesses have urged that the federal government take over the work, with full authority to carry out the new flood control program, doubt is expressed if the states will be willing to give any federal agency the right of eminent domain, with full authority to expropriate property, change the course of rivers and possibly place levee lines so that towns may have to be relocated.

Since Chairman Reid of the committee is in doubt as to the federal government's authority in such a matter, he has asked the Attorney General to submit an opinion on the subject. Special state legislation will have to be enacted, he believes, and, possibly, an amendment to the federal constitution may be found necessary.

The states, it is believed, would be willing enough to avoid those questions, by contributing rights-of-way, if there were not the danger that these rights-of-way will exceed their ability to pay. In Louisiana, alone, it is estimated that rights-of-way may cost as much as $50,000,000. The proposed spillways and reservoirs would require the expropriation of valuable property. If, in the effort to prevent overflow in the future, it should be found necessary to relocate the towns of Plaquemine and Donaldsonville, the expense would be much greater. It is such uncertainties that will make the states particularly reluctant to offer the rights-of-way for their share.

Members of the Flood Control Committee of the Chamber of Commerce of the United States and other witnesses, advocated that the legislation be confined to the Mississippi proper between Cairo and the Gulf. This brought forth strenuous objections from witnesses from tributaries who contend that they should not be discriminated against just because they do not live on the banks of the river that causes their floods.

Despite these difficulties, the committee expects to report a bill just as soon as the engineering reports can be analyzed. The bill probably will authorize an appropriation to carry out the plan as outlined in a specific house document. The document will be the recommendations of the Chief of Engineers. The bill probably will specify certain changes in the recommendations, but every effort will be made by the administration and by many of the legislators from the lower valley to keep amendments at a minimum in the hope that this will expedite the consideration of the bill.

City Holds Up Building Permit On Wrecked Gasholder

The city council of Pittsburgh has announced that no building permit will be issued for the reconstruction of the gasholder, whose explosion in the city's northside, on Nov. 14, killed nearly 30 people and caused wide property damage, until after a conference between the mayor, the council, and department heads to determine what the policy of the city is to be and what form the investigation provided for in a recent resolution, should take. The resolution provides for the appointment of a committee looking to removing from the city all construction activities held as especially hazardous. The resolution was affirmed, and the personnel of the committee will be immediately selected, according to the council.

Indianapolis Officials Reinstated

Following the recent beheading of its chiefs of operating staff (*Engineering News-Record*, Nov. 17, 1927, p. 815) the Indianapolis Board of Sanitary Commissioners by vote of 2 to 1 (the new city engineer being with the majority) has appointed an operating council to consist of the three officers recently dismissed: C. K. Calvert, to have charge of sewage interceptors, sewage disposal, nightsoil disposal, laboratory, power plant and office; Truly Nolen, to have charge of garbage and ash collection and city dump; Floyd Baber, to have charge of garbage reduction plant.

Highway Research Board to Meet

The meeting of the Highway Research Board of the National Research Council will be held in Washington, D.C., Dec. 1 and 2. The reports of the various committees will be divided into three parts: One will include research results which may be considered definitely concluded. The second will be a description of the research now under consideration, and the third, a description of research that should be undertaken. Of special interest is expected to be the report of the committee on the "low cost improved road."

Power Commission Would Pass Some Control to States

Favors Control by State Agencies Where Possible—Need For Co-operation

THE Federal Power Commission in its Seventh Annual Report to Congress emphasizes the need for greater co-operation between federal and state agencies in order to provide effective control by the states of the water power developments within their borders. The commission points out that there are very few states which, otherwise than through general public utility legislation, attempt to exercise control over the disposition or use of their water-power resources. The states that do exercise complete or partial control do so through various means, few of which lend themselves to full co-operation with the Federal Power Commission. To accomplish this and to maintain public title to power resources, the commission recommends that certain principles be established by the states or by the nation.

Chief among the principles which the commission would have maintained is that values inherent in a public resource developed and used as an essential public service, shall not be capitalized for purposes of sale, or establishment of rates or of issuance of securities in an amount in excess of actual reasonable costs. The commission recommends that the states make provision for inspection of construction and for current audit of construction accounts. It also favors requirements by the states that power developments be so located as to make a complete development of a continuous section of a stream rather than to permit plants to be placed at the most favorable site, with sections of the stream which are incapable of economic independent development left unused.

Navigable Waters

The subject of water power on navigable waters is discussed at some length. In the past, a considerable amount of antagonism to the commission has been aroused by its taking jurisdiction over power projects on streams whose navigability or effect upon navigation was in question, and as a result, there has been an attempt to restrict the powers of the commission in this respect. The commission points out that its power of determination as to the navigability of the stream is delegated to it by Congress; that wherever the question of navigability is raised it must, under the

(*Continued on p. 854*)

Chevalier New Head McGraw-Hill Construction Papers

Willard T. Chevalier, business manager, *Engineering News-Record*, has been appointed general manager of the civil engineering and construction publications of the McGraw-Hill Publishing Co., which include *Engineering News-Record, Construction Methods*, and the work of the Business News Department.

Colonel Chevalier joined the staff of *Engineering News-Record* as associate editor early in 1922. Prior to that time, he had been actively engaged in the practice of civil engineering. Starting work in the mechanical and construction departments of Arbuckle Bros., Brooklyn, N.Y., he was later, from 1905 to 1910, in the employ of the Consolidated Telegraph and Electrical Subway Co., New York, in the positions of construction foreman and chief draftsman on design and construction of high tension electric conduits. From 1910 to 1912, he was assistant engineer of the Public Service Commission on the design of rapid transit subways in New York City. Then came a year as field office manager with the Atlantic Gulf and Pacific Co., the general contractors for the Champlain section of the New York State Barge Canal. Three years followed with the same company, when he was in charge of improvement and promotion of waterfront industrial property on New York Harbor. Colonel Chevalier's last position, prior to the war, was as sales manager of the American Bitumastic Enamels Co. From May, 1917, to May, 1919, he was successively captain, major, and lieutenant colonel of engineers with the 11th U. S. Engineers on field service in France, mainly on road and railway construction and maintenance. He returned from the war to become general manager of the American Bitumastic Enamels Co., later the Wailes-Dove Hermiston Corp. This was succeeded by a year's work in technical advertising before he took up editorial duties. Since March, 1923, Colonel Chevalier has held the position of business manager, *Engineering News-Record*.

Agricultural Engineers to Meet to Discuss Farm Structures

At a meeting of the structures division of the American Society of Agricultural Engineers to be held in the Hotel Sherman, Chicago, December 1 and 2, the papèrs and discussion will be devoted to farm structures.

The forenoon session of December 1 will be given to a consideration of farm homes, while in the afternoon of the same day a paper entitled "Determination of Basic Requirements of Farm Structures" by M. C. Betts, architect, U. S. Department of Agriculture, will be given. The prevention of farm fire losses, a discussion as to the place of this structures division in promoting farm structures will conclude the program.

Cross-Connections Held Responsible for Three Outbreaks of Typhoid

Typhoid outbreaks in three cities of New York State are "all presumably the result of illegal cross-connections between public water supplies and polluted supplies" according to the Nov. 21 issue of *Health News*, the official organ of the New York State Department of Health.

Cohoes with 42 cases is the seat of the largest outbreaks. Aside from two contact cases, there was no apparent common cause except the city water supply. The cases were confined to one section of the city, where there was found a "defective cross-connection" in an industrial plant "between the public water supply and the water from the Mohawk River, into which untreated sewage from Schenectady enters." B.coli were found before, but not after, a thorough flushing of the water mains, and the total bacterial count in the water was reduced after the flushing. Samples of water taken in other parts of the city showed no evidence of pollution.

Albany reported 14 cases of typhoid up to the time *Health News* went to press, all in the north end of the city, with 3 other cases elsewhere in the city, having apparent connection with those between in the north end. In October, about 170 persons were reported ill from diarrhea, largely the employees of two factories, and the children attending a school in the north end of the city. The water supply in that part of the city showed evidence of pollution, but elsewhere there was no such evidence. The diarrhea was followed in about a week by the typhoid. "Investigation in the affected area," states *Health News*, showed "three illegal cross-connections between the city water supply and polluted waters, one connecting raw Hudson river water with the filtered and chlorinated public supply." Elimination of these cross-connections, and flushing of the mains was followed by improvement in the sanitary condition of the water.

The third outbreak, with 8 cases of typhoid up to Nov. 1, occurred at Oswego, and is thought to have been due to a cross-connection admitting to the city supply heavily polluted Oswego harbor water, used at a factory for fire protection. The city supply at the factory showed pollution before but not after the removal of the cross-connection.

Under the State Sanitary Code of New York, Chapter VII, 15a, etc., cross-connections are prohibited throughout the state except for temporary use under specified conditions.

Sewage-Works for Dayton and Alliance, Ohio, Approved

Plans for sewage-works for the cities of Dayton and Alliance, Ohio, have been approved by the Ohio State Board of Health, according to its organ, *Ohio Health News*. The Dayton plant is designed for a population of 262,000 and for an average flow of 26 m.g.d. Sewage will be lifted "from the Broadway pumping station below the city" to combined grit and grease removal tanks, from which the sewage will go to two story settling tanks. There will be an incinerator for screenings and grease. Secondary treatment will be introduced when it is required by stream conditions. Provision of this plant results from the order of the State Department of Health "to remedy the serious pollution of the Miami River below the city." Plans for the plant have been prepared and construction will be supervised by Metcalf & Eddy, consulting engineers of Boston.

The new plant at Alliance will have a capacity of 5.4 m.g.d., and serve a population of 36,000. It will replace an old plant "now out of date and greatly overloaded," and will reduce pollution of the Mahoning River below Alliance, "which has been the cause of much complaint." The new plant will include screen and grit chambers, two story settling tanks, sludge beds, trickling filters and secondary settling tanks. The engineer for design and construction is George B. Gascoigne, Cleveland.

President Coolidge on Outlays for Public Works

In the course of an address last week before the Union League of Philadelphia, President Coolidge made some remarks on outlays for public works, including highways, flood control, waterways for navigation, and both the Colorado River and Columbia Basin projects, and better communication with Central and South America. These remarks were prefaced and followed by references to the fact that such outlays are possible because of economies in national expenditure, which are included in the following quotations from the address:

Because of the past insistence on economy in national expenditures, we are in a position to have further moderate tax reduction. But let it be remembered that tax reduction is possible solely on account of economy. Anybody can spend the money somebody else has saved.

We can begin to consider internal developments. Each year $75,000,000 goes out of the Federal Treasury for constructing roads. Flood control must be completed. A waterway system for the Mississippi Valley and its tributaries, with one arm reaching to the Gulf and another to the Atlantic, probably through the St. Lawrence, is only a question of time. The Colorado River project is pressing; the Columbia Basin is not far distant.

Our relationship with the vast terri-

tory between the Rio Grande and Cape Horn in a commercial way will become more intimate. Much of that country could be greatly benefited by lines of aviation, which we should hasten to assist them to open.

A good system of highways should join the principal points in North and South America. While their own governments must necessarily build these, we can assist in their financing.

A.S.M.I. Meeting in Dallas Well Attended

The thirty-third annual meeting of the American Society for Municipal Improvements was held in Dallas Nov. 14-18 with an attendance of slightly over 200. In view of Dallas' extensive program of city planning, to be carried out as a result of a $23,500,000 bond issue, the meeting placed major stress on this phase of its program. Maj. E. A. Wood, city plan engineer of Dallas, presented the Dallas plan much of whose detail has been worked out under his supervision. W. W. DeBerard, associate editor, *Engineering News-Record,* as chairman of the city planning committee read the committee's annual report. Other speakers, on subjects pertaining to their particular cities were: Jacob L. Crane, Jr., city plan engineer, Chicago; G. W. Huyler, chief engineer, Regional Plan Association, San Francisco Bay Counties; George H. Herrold, St. Paul; W. B. Fowler, city engineer, Memphis, Tenn.; Richard Diehl, city manager Two Rivers, Wis.; and J. B. Blandford, Jr., director, Cincinnati Bureau of Municipal Research.

Other subjects upon which papers were read included street paving, maintenance, and snow removal; chlorination and filtration of water supplies; street lighting; traffic problems; sewerage and garbage disposal.

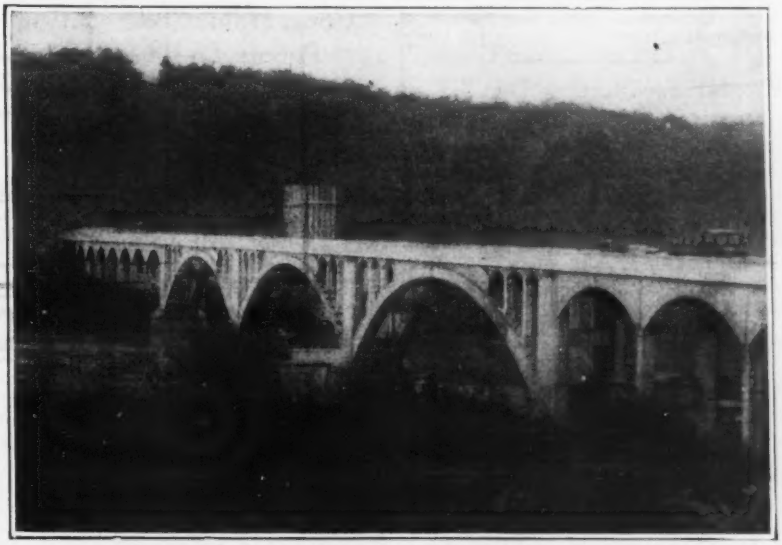
Officers elected were: George F. Fisk, Buffalo, N. Y., president; John Kolrer, New York City, J. W. Reed, New Orleans, and P. L. Brockway, Wichita, Kans., as vice-presidents. The annual meeting in 1928 will be held in Detroit.

Excess Condemnation to Promote New York Housing

Modifications of the excess condemnation sections (Nos. 970 A and B) of the charter of New York City were approved by a large majority in a referendum vote on Nov. 8. The changes are in the interest of housing. They extend to 99 years, the possible term of lease of land taken by excess condemnation in connection with streets, parkways and other public improvements. Heretofore such land could be leased for 10 years and the lease renewed for a like period. Leases must be made to the highest bidder, under terms fixed by the Board of Estimate. The amendments are designed to help provide low rental houses. Opponents of the amendments obtained a restriction to buildings the first floor of which is used for stores.

Concrete Arch Bridge Being Tested to Destruction

The accompanying illustration shows the Swift Island bridge over the Yadkin River near Albemarle, N. C., which is being subjected to an extensive series of tests by the North Carolina State Highway Department in co-operation with the U. S. Bureau of Public Roads. The bridge is to be submerged by the construction of a power dam farther down the river, and highway traffic has been diverted to a new high-level bridge farther upstream. A long series of tests is being made upon the center span by means of large water tanks which can be moved across the deck of the bridge to concentrate the load at various points. One of the large wooden tanks is shown in the illustration at about the center point of the span. When filled with water it weighs 330,000 lb. A similar tank will be used to increase the load when desired. It is expected to continue the test until the arch is destroyed. Telemeters set at various points on the arch ring are used to determine the stresses obtained under different conditions of load, and the results are compared with similar results obtained from tests made on a celluloid model of the span at Ohio State University.



CONCRETE ARCH BRIDGE BEING SUBJECTED TO TEST

The first series of tests was made with the bridge in its normal condition. A second series is now in progress in which the spandrel walls are cut away and the continuity of the floor system is broken, so that the ribs will act as nearly as possible as simple arches under the loading transmitted to them through the columns.

The arch span under test consists of two ribs 4 ft. wide and 4 ft. 6 in. thick at the springing line and 2 ft. 6 in. thick at the crown, having a total span of 146 ft. 3 in. in the clear. The bridge was built in 1922. Upon the completion of the tests, the remainder of the bridge will be demolished by the War Department by military methods.

Revision in Public Works Plan

The American Engineering Council reports that as a result of suggestions received from Secretary Hoover and Secretary Work, it has been decided to make a change in the public works bill. The present change provides for retaining the name of the Department of the Interior in which a Division of Public Works is to be organized, rather than to change the name of the whole department as was previously proposed. The administrative board of American Engineering Council has given formal approval to this proposed change and to an agreement with Secretaries Hoover and Work to sponsor the measure with these changes.

Day-Labor Bill to Be Again Presented to Congress

On the convening of the congress, Representative Campbell, Pennsylvania, will reintroduce his bill which would require federal agencies to call for bids on practically all construction work. For the most part, the bill is identical with the measure which the committee reported favorably at the last session. A provision has been inserted exempting the Panama Canal from the operations of the proposed legislation, and a new condition requires that "within 60 days after the completion or acceptance of any construction project there shall be compiled a statement of the total expense, together with a detailed statement of any change made in the plans and specifications as well as the time of completion on which the original estimate was based, all filed and made available for public examination in the office of the department in Washington."

For the sake of clarity, a sentence has been added to the section requiring bids to explain that "if such bids be not reasonable in the opinion of said departments, bureaus, commissions, or other agencies, the said departments, bureaus,

commissions, or other agencies may do said construction project by day labor or any other method." The provision of the committee bill providing that the federal agencies may list government-owned equipment, and authorizing facilities for the sale of surplus federal equipment, has been dropped from the bill which will be introduced at the coming session. The section requiring the summary dismissal of any person violating any provision of the proposed act, also has been eliminated.

This is the legislation which is being sponsored by the Associated General Contractors. That organization is convinced that construction work can be done by private contractors at less rates than a government agency can do it on the day-labor basis.

The bill met vigorous opposition at the last session of Congress and made no progress after it reached the House calendar. A minority of the committee, in a formal report, said it would place the government "at the mercy of contractors." Adverse reports on the legislation were submitted by the War and Navy Departments and the Bureau of Reclamation.

Program for Meeting, Dec. 1-3, of American Construction Council

At the sixth annual convention of the American Construction Council, in St. Louis, Dec. 1-3, the general theme of discussion will be, "The Construction Industry—Its Needs and What Should Be Done About Them." Among the subjects which will be taken up at the convention are:

"The Economic Relationships of Construction"—discussion led by Dr. Richard T. Ely, director, Institute for Research in Land Economics and Public Utilities, Northwestern University, Chicago, and

"The Relation of the Construction Industry to the Future Development of the Mississippi Valley" by E. J. Russell, architect and chairman of the St. Louis regional committee of the American Construction Council.

Suggested changes in the constitution and by-laws which will come up for consideration include (1) that the regional chairmen of the Council be ex-officio members of the Board of Governors; (2) that in order to give wider representation among the elected officers there be five vice-presidents instead of three; (3) that the membership dues of the Council be reclassified so as to place greater emphasis on the larger contributions; (4) that local trade associations be eligible as sustaining members; (5) that group 8 of the Board of Governors be confined to financial, surety, realty and directly allied groups and that boards of trade, chambers of commerce, etc., be placed in group 11; (6) that recognition in voting power be given sustaining and donor members in determining vote within their respective membership group, and (7) that the Board of Governors shall meet at least twice a year.

Engineering Fifty Years Ago

From *Engineering News*, November 24, 1877

A RECENT letter to the *Scientific American* in its promises transcends the remarkable. It appears that the electrician, Mr. T. A. Edison, has produced an apparatus on principles similar to the telephone, which permanently records on a slip of paper the sounds of the human voice so that they can be reproduced by another apparatus at any future time. This he expects to perfect within a year. Can we conceive anything more wonderful, and yet in its scientific aspects it is comparatively simple. Words may well fail to describe the possibilities of such an invention.

Court Holds Concrete Gun Patent To Be Invalid

In a decision handed down on Nov. 12 by the U. S. District Court, western division, at Seattle, Wash., Judge Bourquin decreed that the McMichael concrete gun patent held by the Concrete Mixing & Conveying Co. is void for want of novelty and invention. The suit was brought by this company against R. C. Storrie & Co., contractors, and charged that the Storrie Co. in using the Hackley concrete gun in the Skagit tunnel of the Seattle municipal power project infringed the McMichael patent.

In the decision, which comprises sixteen legal size pages, the judge reviewed numerous patents, old and new, and various prior uses of equipment for the pneumatic placing of grout and concrete. To establish a background for the findings, the decision goes into the fundamental principles in an analytical way. Regarding plaintiff's theory of operation under the McMichael patent with reference to an alleged slug action the decree says: "To establish or secure movement of the concrete in alternate slugs of concrete and air would do violence to the laws of nature and confound reason. It cannot be done."

With reference to the essential claims of the defendant as to the operation of the Hackley gun in the matter of a continuous concrete discharge, the decision said: "The proof is clear, by plaintiff witness as by defendant and some who are interested in plaintiff, that the concrete discharges in a continuous aerated or mixed stream of concrete and air and not at all in any slug formation."

In summing up points brought out in the case, the decision points out that "Hackley's apparatus is a different combination than McMichael's, has no upright, cylindrical, hopper-bottomed container, is without the U-bend, employs no upper air valve, save some incidental back pressure, does not discharge slug fashion as claimed in the invention of McMichael and so does not infringe."

Fundamentally the suit was a test of the basic claims on which the McMichael patent was issued and with reference to these claims the decree reads: "The claims in suit are void for want of novelty and invention. Decree accordingly."

Power Commission Report

(*Continued from p. 851*)

present law, be passed upon by the commission. Any attempt to limit its jurisdiction in this respect will, according to the Commission, make it necessary to go to Congress for such a determination, and will not, as it might appear, remove the matter from federal jurisdiction.

Supervision of Accounts

The commission repeats its recommendation of last year that the funds received from licenses under the water power act be segregated for its use, in order that it may employ an adequate staff to supervise the construction cost and charges to capital accounts of concerns building power projects under federal licenses. With its present limited force the commission is unable to keep up with the work before it. It already has knowledge of deliberate overcharging of investment accounts which should be investigated before too much time elapses.

Reviewing its work, the commission points out that 31 new projects having an installed capacity of 362,000 hp. when completed have been started during the fiscal year, bringing the total of projects under its jurisdiction completed or under construction at the close of the year, up to 128 with a proposed aggregate installation of 4,610,000 hp.

Bids on Large Dam Called for by Hudson River Regulating Board

The Hudson River Regulating District is calling for bids on the construction of a dam on the Sacandaga River at Conklingville, N. Y. The dam is the first to be built by the district for the control of stream flow in the Hudson River. It is to be located about 6 miles above the confluence of the Sacandaga and the Hudson Rivers in order to form a reservoir in the Sacandaga Valley about 27 miles long and having an area of 28,000 acres. The dam is to be an earthen structure with a sidehill spillway. It is to be built by the semi-hydraulic fill method.

The estimated cost of the entire Sacandaga reservoir project is approximately $9,000,000. This includes land for the reservoir, property damages, and the cost of relocating railroads and highways. Contracts for the highway relocation work were let early this year. Clearing of the reservoir site is being done by force account.

Edward H. Sargent, of Albany, is chief engineer of the regulating board.

Personal Notes

A. H. MOORE has been appointed city engineer of Indianapolis, Ind., succeeding PAUL R. BROWN, resigned. For several years Mr. Moore has been in partnership with B. T. Jeup, under the name of Jeup & Moore. Prior to 1901 Mr. Moore was deputy city engineer of Indianapolis for several years.

GEORGE D. BURR, assistant engineer in the division of design of the Bureau of Engineering, San Francisco, Calif., has been appointed city traffic engineer at San Francisco, under a new ordinance which created a division of street traffic under the jurisdiction of the Department of Public Works and the city engineer. Mr. Burr's duties will include study of traffic accidents and of street traffic conditions, and charge of traffic signs, signals and markings.

HENRY M. WAITE has been appointed chief engineer of the Cincinnati Union Terminal Co., which plans to build a large new passenger station. C. A. WILSON is consulting engineer. Mr. Waite was at one time city engineer of Cincinnati, and later city manager at Dayton, Ohio. He saw service abroad during the war and until recently has been in engineering practice and with the Lord Construction Co., New York.

ROBERT H. ERLEY, village engineer of Dearborn, Mich., has been appointed city manager of that place.

J. HARPER HAMILTON, Pierre, S. D., who has been assistant engineer of bridges in the South Dakota State Highway Department, has been appointed bridge engineer of the department, effective Dec. 1, to succeed J. E. Kirkham, whose resignation from the position was announced in these columns last week. KENNETH SCURR was appointed assistant bridge engineer following Mr. Hamilton. Both men have been in the bridge work of the highway department almost since its inception, Mr. Hamilton since 1919 and Mr. Scurr since 1920. Both men were educated at Iowa State College.

SIR HENRY THORNTON, president of the Canadian National Rys., has gone to Mexico to study the financial conditions of the Mexican National Rys. in order to suggest a plan for their reorganization that will place them on a paying basis. He will do this work for the Mexican government, to which his services are loaned by the Canadian National Rys.

ALEX GRAY, engineer in charge of the St. John harbor for the Dominion Department of Public Works, has been appointed chief engineer and manager of the St. John Harbor Commission, St. John, N. B., effective Nov. 1. Mr. Gray went to Africa from Scotland, where he had worked with the Ordnance Survey and had spent a year in the city engineer's office at Dundee, and from Africa came to Canada in 1905. He was assistant engineer for the Dominion Coal Co. and then for the Grand Trunk Ry. was resident engineer on maintenance. This was followed by charge of the Ottawa River storage for the Dominion Department of Public Works and this in turn by the work at St. John. In our issue of July 21, p. 119, it was erroneously stated that Burton Hill was appointed chief engineer of the St. John Harbor Commission.

G. W. HARRIS, assistant chief engineer of the Atchison, Topeka & Santa Fé Ry. System, has been made acting chief engineer while C. F. W. FELT, chief engineer, is on leave of absence.

Engineering Societies

Calendar

Annual Meetings

ASPHALT PAVING CONFERENCE: Under the auspices of the Asphalt Association and Association of Asphalt Paving Technologists; annual conference Atlanta, Ga., Nov. 28-Dec. 2, 1927.

HIGHWAY RESEARCH BOARD, NATIONAL RESEARCH COUNCIL, Washington, D. C.; Annual meeting, Washington, D. C., Dec. 1 and 2, 1927.

INTERNATIONAL ASSOCIATION OF STREET SANITATION OFFICIALS, Chicago, Ill.; Annual Conference, Detroit, Mich., Jan. 9-10, 1928.

AMERICAN ROAD BUILDERS ASSOCIATION, Washington, D. C.; Annual Convention, Cleveland, Ohio, Jan. 9-14, 1928.

AMERICAN SOCIETY OF CIVIL ENGINEERS, New York City; Annual Meeting, New York City, Jan. 18-20, 1928.

ASSOCIATED GENERAL CONTRACTORS, Washington, D. C.; Annual Convention, West Baden, Ind., Jan. 23-27, 1928.

THE NEW JERSEY SANITARY ASSOCIATION will hold its 52nd annual meeting at Princeton Inn, Princeton, N. J., Dec. 2 and 3. The only strictly engineering topic is the address of the president, Chester G. Wigley, consulting engineer, Atlantic City, who will review "Recent Progress in Sanitary Engineering Work in the State of New Jersey."

THE AMERICAN SHORE AND BEACH PRESERVATION ASSOCIATION will hold its annual meeting Dec. 5 and 6 in Jacksonville, Fla., at the Carling Hotel. An interesting program is being arranged, representative of the work which the association has done during its single year of existence and of work planned in future.

THE ARIZONA SECTION of the American Society of Civil Engineers held its annual meeting at Phoenix, Nov. 5, with a program including talks on the national reclamation irrigation policy, the Coolidge dam, and the Stevenson Creek arch dam investigations with pictures. Officers for the coming year are: President, Howard S. Reed, consulting engineer, Phoenix, and secretary-treasurer, R. A. Hoffman continued from this year.

Obituary

WILLIAM S. HUMBERT, Los Angeles, Calif., died in that city Nov. 11. Mr. Humbert, before going to Los Angeles, where he had lived for twenty years, was engaged on the construction of one of the power tunnels at Niagara Falls, N. Y., and he had been an assistant engineer on construction of the Croton aqueduct for New York City water supply. He was born in Brooklyn and graduated in engineering at Columbia University.

GUSTAVE A. M. LILJENCRANTZ, Stockholm, Sweden, who prior to his retirement and return to Sweden in 1916 served 47 years in river and harbor improvement work in the Great Lakes region in the United States, died recently at Stockholm at the age of 85 years. Mr. Liljencrantz was born in Stockholm and was a graduate of the Royal Technical Institute there. In 1869 he came to the United States and became associated with the U. S. Army Engineers, first at Milwaukee, Wis., and in 1870 was assigned to the Chicago office of the U. S. Engineers and served under many district engineers there, as civilian assistant engineer. Major Rufus W. Putnam, former district engineer of the Chicago district said of him: "His influence during the crucial period of waterway development has been a tremendous factor in the ultimate success of many wide-spread projects launched during his half-century of service." Mr. Liljencrantz was a charter member of the Western Society of Engineers.

EDWARD BROWNING, Philadelphia, secretary of the Belmont Iron Works, Engineers and Contractors, died Oct. 22 at the age of 41 years. He was a graduate of Sheffield Scientific School.

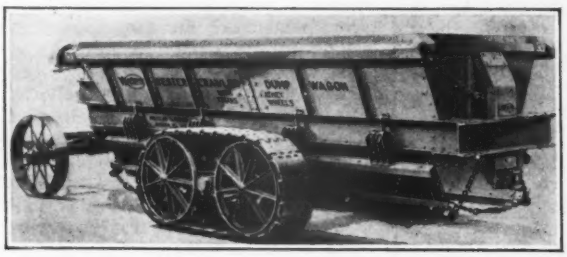
JAMES C. HARDING, civil engineer, Mount Vernon, N. Y., was killed Nov. 16 in an automobile accident in Connecticut, and his son, Joseph B. Harding, 16 years old, died Nov. 19 from injuries received in the same accident. James C. Harding was a native of Pittsfield, Mass., and his first engineering work was on sewer construction there; later he was assistant city engineer at Pittsfield. From 1906 to 1911 he was associated with Hering & Fuller, New York City, and had charge of the design of several sewerage systems for cities in New York State, Atlanta, Ga., and other places. The next two years he was associated with George W. Fuller in New York. From 1913-17 he was in business for himself, then associated with Fuller & McClintock, and last July again established his own engineering practice. His work related principally to sewage-works, including the intermittent sand filters at Pittsfield, the Imhoff tank and sprinkling filters at Schenectady, the activated sludge plant at Mamaroneck and the disposal works of the General Electric Co. at Pittsfield and Schenectady.

Construction Equipment and Materials

A Section Devoted to What the Manufacturer Is Doing for the Engineer and Contractor

Seven Cubic Yard Dump Wagon Mounted on Crawlers

A new steel dump wagon, recently designed by the Western Wheeled Scraper Co., Aurora, Ill., has a capacity of 7 cu.yd., and is mounted on Athey truss wheel crawler units which carry 90 per cent of the load. The wagon is designed for use behind a crawler tractor,

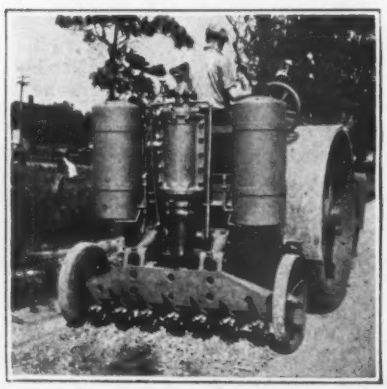


enabling a contractor to utilize the full power of the tractor in earth moving. The crawler mounting enables the wagon to carry full load over sand or other soft soil where even smaller wagons, with round wheels, could not travel, and over very rough ground where small wagons could travel only with difficulty.

The new wagon weighs approximately 9,800 lb. and it is provided with two sets of bottom-dump doors, operated by chains controlled through side shafts on the outside of the body. It is said that in practice on levee work in the south, one wagon takes the place of six 4-up, 1½-yd. dump wagons, thus eliminating the upkeep of 24 mules.

Ten Ton Motor Roller Uses Double Worm Gear Drive

A new 10-ton four-cylinder motor roller, with modern stream-line design and heavy scarifying equipment, has recently been developed by the Austin-Western Road Machinery Co., Chicago. The new model is known as the "Autocrat." Its most outstanding mechanical feature is the use of a duplex worm drive. This drive, instead of being the final drive, is the primary drive from motor to clutches. Also, instead of using the customary worm and a single worm gear, two worm gears are used, one located above and the other beneath the worm, and thus driven by it in opposite directions. This sort of drive is claimed to be extremely well adapted to the operation of a road roller which, unlike a motor truck or other automotive vehicle, is working in reverse gear as much as in forward gear, and must therefore have the same traveling speed forward and reverse. The worm gear requires practically no adjusting, and permits an immediate reduction in speed from 1,000 r.p.m., the governed speed of the motor, to 207 r.p.m., the speed of the clutch shaft. The worm and its shaft are a single piece of alloy steel, while the two worm gears are special steel bronze. Combined splash and force-feed lubrication insure efficient operation and long life.



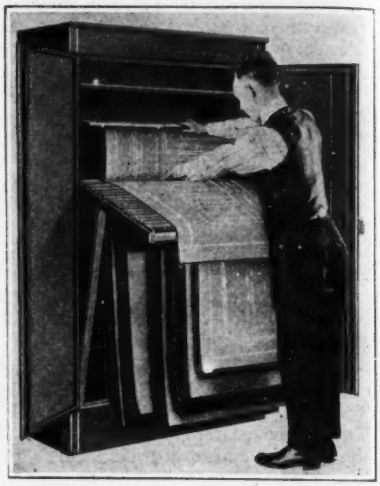
Twin disk clutches, adjusted through a port in the frame side-plate, and operated by a single lever, are used. An electric self-starter is regular equipment. Oil and gasoline gages and all electrical controls are mounted on a panel directly in front of the operator's seat. Three-speed transmission instead of the two-speed, and a sprinkler system for wetting down the faces of the rolls, are available when desired.

Filing Cabinets Make Large Blue-Prints Easily Available

A blueprint filing cabinet has been developed by the Hamilton Mfg. Co., Two Rivers, Wis., to file efficiently large records or plans. When the rack is pushed in, and the doors closed, the cabinet occupies 18 in. of floor space in depth. It is 72 in. high and will accommodate some 2,500 to 3,000 prints, drawings, or tracings, from the smallest size desired up to those 70 in. in length. It is known as the Hamilton-Calumet vertical plan file, and is made in five sizes to accommodate maximum sized prints as follows: 24 in. x 70 in.; 30 in. x 70 in.; 36 in. x 70 in.; 42 in. x 70 in.; and 48 in. x 70 in.

The binders in the cabinets will take up to 100 drawings, and each has a label holder for properly labeling the contents of the binder. The binders are easily removed and replaced in the cabinet.

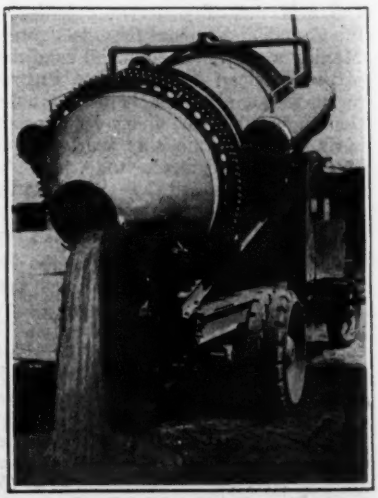
The rack holding the binders is made in three styles: the plain rack which holds 26 full width binders; style A rack which is divided in the center and will take 26 half width binders on each side, or a total of 52 binders; and style B rack, which will accommodate 13 full width binders at the rear, the front half



being divided in the center, taking 12 half width binders on each side, a total of 37 binders. The cabinet is of furniture steel finished in olive-green baked enamel.

Ready-Mixed Concrete Provided By Truck-Mounted Mixer

Designed to afford the building material distributor a means of selling a finished product—ready-mixed concrete,—a new truck-mounted concrete mixer has been placed on the market by Transit Mixers Co., Inc., San Francisco. The mixing drum which can be mounted upon any standard make of truck, 2½ tons or over, consists of a cylindrical shell with one end closed and the other containing a funnel-shaped opening through which the aggregates enter and discharge. Water is carried in separate tanks on both sides of the mixer, and the connection is such that

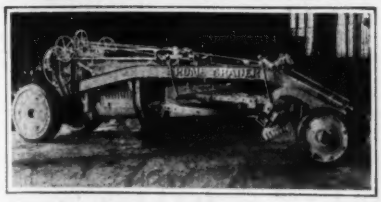


it can be quickly released when the wet mix is desired. All controls, for both water and mixer, are operated from the driver's seat.

The operation plan is, that while the aggregates are being charged into it at the batching plant, the shell is rotating and thoroughly mixing the dry batch, which is then ready to receive the water when the job is reached. Timken bearings are used throughout the mixer, and the water tanks are of a light weight special alloy rust-resisting material. The mixers are now available in 2 and 3-cu.yd. sizes.

New Motor Grader

Combining the features of the regular line of high lift graders manufactured by the Rome Mfg. Co., Rome, N. Y., and the International McCormick-Deering tractor, a new machine manu-

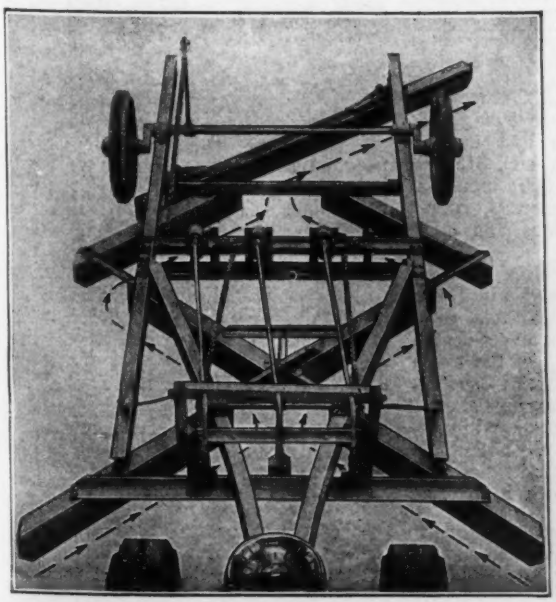


factured by the former company has recently taken a place in the one-man grader field. The machine is designed not only as a maintainer, but for real road building operations. Careful study has been given to weight and balance in order that it can be easily controlled in all positions. Both regular wheel and crawler type traction are available. Scarifying attachment, cabs, etc., are also optional equipment.

Road Maintainer Has 40 Ft. of Blades

The one-man road maintainer manufactured by J. D. Adams & Co., Indianapolis, Ind., has its 40 ft. of blades arranged in such a manner that the road material is worked back and forth across the road four times in one passage of the machine. Ordinarily 9 ft. wide extensions can be added to one side of the machine making it 10½ ft. wide, or to both sides, increasing its cutting width to 12 ft.

Special rigidity is claimed for the maintainer since, with the exception of the drawbar and the axle, it is one solid unit. Three operating controls immediately back of the tractor seat operate worm-and-gear mechanism by which the blades are raised. All blades, but the rear one, are in a fixed position at 45-deg. angle. The rear blade is fastened to each frame member by clamp brackets which may be adjusted to set the blade in any desired position. Special hitches are provided for any type of tractor. Rubber tired wheels are recommended.



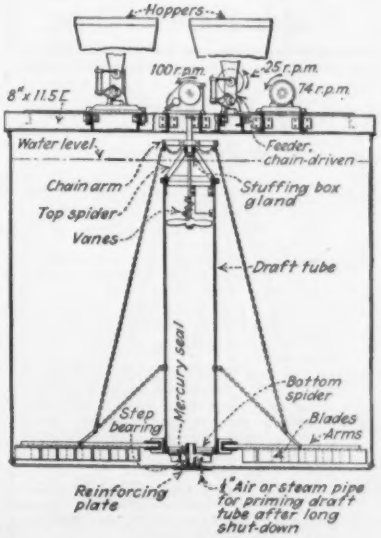
Preservative Treatment for Wood

A new development in the preservative treatment of timber for buildings, mines, railways and general purposes is the Wolman process which is being introduced by the American Lumber & Treating Corporation, 1138 Lake Shore Drive, Chicago. This process consists in the impregnation of the wood with Wolman salts, a combination of sodium-fluoride, dinitro-phenol and neutralizing chromates. The empty-cell method of treatment is used, the solution being applied under pressure in a retort, in the usual way, and a vacuum being then created to withdraw a part of the solution from the wood. This treatment is varied so as to give a final retention ranging from 0.16 lb. of dry salt per cubic foot of wood for mine timbers, to 0.25 lb. for building material and 0.30 lb. for poles, railway ties and other timber exposed to the weather. The temperature of the solution is 150 to 180 deg. F., and the pressure maintained is about 125 lb. After treatment, the timber is allowed to dry for about three weeks.

Timber treated in this way can be painted, and is said to be free from stain or odor. It is claimed that the salts are permanently fixed so as not to be leached out by dampness or wet, and that they have no effect upon metal, while they have an important effect in reducing the inflammability and combustibility of the wood. They are said to have an exceptionally high toxic value and to repel the white ants which are destructive of wood in many parts of this country. Timber treated in this way has been used already for flooring and roofing in several large industrial plants, and for the flooring of the boardwalk at Coney Island, New York, while it has been ordered for the new Rockaway boardwalk and is being tried also in railway car construction. The Wolman process was invented in Germany, where it has been used extensively on timber for mine props, railway ties, car lumber and general building purposes. In Central America, such treated timber is in use for railway trestles, ties and buildings. The salts are manufactured under the direction of the American Wood Impregnation Corporation, 25 Broadway, New York, and the treating is done at different commercial plants to the order of the American Lumber & Treating Corporation, Chicago.

Chemical Dosing of Water Aided By New Mechanical Mixer

For use in the water-works field, where efficient mixing is important both for the chemical softening of hard water and the chemical dosing of turbid waters, the Dorr Co., New York City, has developed a mechanical mixer known as an impeller agitator. One of its most important features is its ability to turn



over a large volume of water at a velocity which does not break up flocs.

As shown in the accompanying illustration, the tank contents are circulated through a centrally located draft tube in which a marine propeller is rotated. The draft tube also revolves slowly, and is equipped at its lower end with a pair of radial arms to which plow blades are attached. These blades and the propeller thus give the tank contents a general circulating movement in both the horizontal and vertical planes, which is claimed to result in a high rate of change of position of the various particles in the water being treated. The path of travel is first upward through the draft tube, second radially outward just below the surface, third down

through the annular space between the draft tube and the tank shell, and fourth, radially inward to the base of the draft tube. The slowly moving rake arms keep the bottom of the tank free from settled solids, and also move such particles to a point under the draft tube into the sucking action of the propeller.

The draft tube and propeller are driven by a special two-speed reducer, the solid propeller shaft running within the hollow draft tube shaft. The weight of all of the superimposed equipment is carried by steel supports spanning the tank. The propeller operates at a much higher speed than does the draft tube. Radial arms may be lifted by means of the chains shown.

The water to be treated enters through an opening in one side of the tank slightly below the surface, and overflows through a similar opening diametrically opposite but at the water level. The time required to complete the circulation of tank contents is influenced by the speed, pitch and diameter of the propeller. As shown, mechanical feeders for adding lime, soda ash, ferrous sulphate, alum, etc., may be placed upon the supporting structure.

Manufacturers and Trade Associations

Calendar

Annual Meetings

NATIONAL EXPOSITION OF POWER AND MECHANICAL ENGINEERING. Sixth Annual Show. New York City, Dec. 5-10.

POWER TRANSMISSION ASSOCIATION, Philadelphia; Annual meeting, New York City, Dec. 7.

NATIONAL SAND AND GRAVEL ASSOCIATION, Washington, D. C.: Annual Convention, Detroit, Jan. 4-6, 1928.

ASSOCIATED EQUIPMENT DISTRIBUTORS, Milwaukee; Annual meeting, Cleveland, Jan. 6-7, 1928.

AMERICAN ROAD BUILDERS ASSOCIATION, Washington, D. C.; Annual Convention, Cleveland, Ohio, Jan. 9-14, 1928.

NATIONAL CRUSHED STONE ASSOCIATION, Washington, D. C.; Annual Convention, West Baden, Ind., Jan. 16-19, 1928.

New Publications

Cement Tile Roo'ng — American Cement Tile Manufacturing Co., Pittsburgh, has just released a 76-p. catalog illustrative of installations of "Cementile" roofing. The catalog contains 40 pp. of roofing installation photographs and 36 pp. of specifications, data and detail sheets, showing the application of this particular roof to various types of construction. A supplement catalog, containing the specifications and detail sheets only, and designed primarily for engineers, architects and drafting rooms, has also been issued.

Business Side of Construction

Facts and Events That Affect Cost and Volume

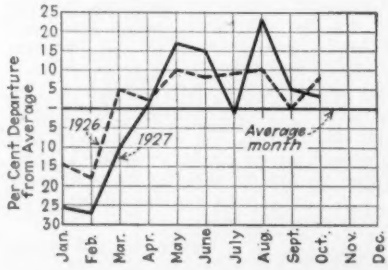
Construction in the First Ten Months

CONTRACTS reported by *Engineering News-Record* in the first ten months of 1927 total $2,618,600,000 compared with $2,417,423,000 in the same period of 1926. This 8 per cent gain is attributable to heavy lettings of sewers, bridges, roads, commercial buildings and unclassified structures—particularly pipe line construction. There are declines in water-works construction and in industrial building.

Particularly interesting, in view of its barometric value, is the fact that the industrial building decline was entirely in the first five months of 1927. Each of these months was under the corresponding month of 1926, while each of the latter five months has been above the value for its corresponding month in 1926. The decline was 11 per cent from the 1926 value.

Road lettings have been steady and in good volume, as usual, and are 7 per cent ahead of last year. Their proportion to total heavy construction is 18 per cent in 1926 and 17.5 per cent in 1927.

The seasonal range for the two years is given in the chart, which shows the per cent that each month's contract value bears to the ten month's total for each of the two years.



The individual contracts that make up these statistics are of the following costs or more: Water-works and excavation, drainage, irrigation, etc., $15,000; other public works, $25,000; industrial buildings, $40,000; commercial, education, institutional, religious and other buildings, $150,000.

The F. W. Dodge building statistics covering all contracts awarded in thirty-seven states show a decline in total value of 4 per cent. The decline in residential construction (40 per cent of the total) is 5 per cent. Other classes to show a decline are educational, hospitals and institutions, military and naval, and industrial. The falling off in the latter field is 41 per cent from 1926, indicating that curtailment has been greatest in the case of smaller projects.

Geographically, according to *Engineering News-Record* statistics, the declines have been in the South, and to a slight extent in New England. The principal gain was in all states west of the Mississippi—23 per cent.

Canadian contracts total $118,332,000, compared with $100,387,000, in the ten months of 1926.

NEW WORK PROPOSED IN OCTOBER

In October, 1927, *News-Record* reported $281,000,000 worth of projects planned but not yet ready for estimates. Of this, 59 per cent was for private construction. The figures for October, 1926, are $351,000,000, of which 61 per cent was private.

Paving Costs

The prices per sq.yd. given in the following table are for concrete pavement in various thicknesses, as compiled from data furnished by the Bureau of Public Roads. The average distance over which materials were hauled to the job, was 3.13 mi. Common laborers received an average wage of 32.3c. per hr., with the range from 20 to 50 cents.

County	Date 1927	Sq.Yd.	Price per Sq.Yd.
(6-in.)			
Berks, Pa.	June 24	29,024	$2.90
Cambria, Pa.	June 23	2,401	3.10
Harris, Tex.	Aug. 15	80,935	2.00
Ellis, Tex.	Aug. 15	44,104	1.94
Anderson, Tex.	Aug. 15	108,176	2.23
Freestone, Tex.	Aug. 15	165,000	2.67
Washington, Miss.	Aug. 8	50,594	2.08
Montgomery, Ala.	Aug. 19	43,074	.93
Cullman, Ala.	Aug. 19	165,551	1.30
Jefferson, Ala.	Aug. 19	184,129	1.29
Autanga and Montgomery, Ala.	Aug. 19	76,136	.99
Mobile, Ala.	Aug. 19	121,891	1.36
Butler, Ala.	Aug. 19	119,418	1.27
Logan, Okla.	Aug. 25	454	2.48
Logan, Okla.	Aug. 25	65,625	2.30
Logan, Okla.	Aug. 25	41,353	2.15
Logan, Okla.	Aug. 25	67,017	2.30
Stephens, Ga.	Aug. 25	37,536	2.16
Muskogee, Ga.	Aug. 25	115,042	2.06
Terrell, Ga.	Aug. 25	36,044	1.95
Troup and Coweta, Ga.	Aug. 25	86,250	1.90
Union, Ark.	Aug. 30	192,779	2.30
Juneau, Wis.	Sept. 9	40,700	2.04
Rutherford, Tenn.	Sept. 16	1,290	2.12
Davidson, Tenn.	Sept. 16	78,626	1.96
Obion, Tenn.	Sept. 16	105,653	2.07+
Somerset, Pa.	Sept. 22	10,435	3.05
Greene, Ala.	Oct. 5	200,580	1.21
(7-in.)			
Dauphin, Pa.	June 23	11,899	3.33
Berks, Pa.	June 23	20,054	2.70
Lancaster, Pa.	June 24	50,035	2.90
Westmoreland, Pa.	Aug. 12	21	3.00
Chester, Pa.	Aug. 12	26,235	3.07
Greene, Pa.	Aug. 12	40	3.60
Cheboygan, Mich.	Aug. 2	60,669	1.27
La Grange, Ind.	July 26	115,986	1.13
Bremer, Ia.	Aug. 19	156,201	2.20
Boulder, Colo.	Aug. 18	3,970	*2.80
Montcalm, Mich.	Aug. 24	68,629	1.24
Franklin, Ia.	Sept. 2	107,336	2.24
Hendricks, Ind.	Aug. 23	77,230	1.37
Indiana, Pa.	Sept. 23	59,882	3.05
Jefferson, Pa.	Oct. 14	52,070	2.90
Kent, Mich.	Sept. 15	2,263	.50
*7½ in. thick.			
(8-in.)			
Genesee, Mich.	Aug. 27	96,984	1.55
Oakland, Mich.	Aug. 26	82,356	1.50
Warren and Mercer, Ill.	July 27	37,415	1.58
Macomb, Mich.	Oct. 1	11,546	1.41
(9-in.)			
Cowley, Kans.	July 19	35,158	2.16
Jefferson, Ala.	Aug. 19	27,000	.78
Gratiot, Mich.	Sept. 8	880	.55
Mecosta, Mich.	Oct. 5	980	.50
Wayne, Mich.	Oct. 5	8,832	1.90

Cost of Earth Excavation

The following prices per cu.yd. are from reports of the Bureau of Public Roads:

County	Date 1927	Cu.Yd.	Price per Cu.Yd.
Berks, Pa.	June 24	25,908	$1.20
Dauphin, Pa.	June 23	1,960	1.50
Berks, Pa.	June 23	5,260	1.10
Cambria, Pa.	June 23	12,734	.68
Lancaster, Pa.	June 24	11,532	1.38
Cowley, Kans.	July 19	20,514	.40
Harris, Tex.	Aug. 15	61,226	.26
Westmoreland, Pa.	Aug. 12	34,195	.76
Chester, Pa.	Aug. 12	11,456	1.10
Cheboygan, Mich.	Aug. 2	84,321	.46
La Grange, Ind.	July 26	33,690	.50
Lexington, S. C.	Aug. 16	67,000	.38
Ontonagon, Mich.	Aug. 12	124,314	.60
Bremer, Ia.	Aug. 19	36,807	.50
Pottawattomie, Ia.	Aug. 19	24,931	.75
Washington, Idaho	Aug. 13	7,530	.50
Boulder, Colo.	Aug. 18	200	.90
DeKalb, Ala.	Aug. 23	42,600	.30
Madison, Ala.	Aug. 23	92,792	.32
Limestone, Ala.	Aug. 23	124,979	.30
Logan, Okla.	Aug. 25	2,000	.40
Logan, Okla.	Aug. 25	1,000	.45
Stephens, Ga.	Aug. 25	6,336	.40
Muskogee, Ga.	Aug. 25	59,475	.33
Terrell, Ga.	Aug. 25	22,000	.35
Troup and Coweta, Ga.	Aug. 25	51,120	.32
Juneau, Wis.	Sept. 9	25,500	.40
Luce, Mich.	Aug. 27	35,656	.48
Genesee, Mich.	Aug. 27	88,440	.50
Montcalm, Mich.	Aug. 24	70,015	.48
Oakland, Mich.	Aug. 26	106,357	.55
Hendricks, Ind.	Aug. 23	29,041	.40
Warren and Mercer, Ill.	July 27	34,770	.45
Rutherford, Tenn.	Sept. 16	12,531	.45
Jefferson, Pa.	Oct. 14	20,945	.70
Macomb, Mich.	Oct. 1	60,007	.38
Gratiot, Mich.	Sept. 8	15,668	.48
Mecosta, Mich.	Oct. 5	56,562	.46
Wayne, Mich.	Oct. 5	950	1.00

Cost of Rock Excavation

In the accompanying tabulation, prices per cu.yd. are from reports of the Bureau of Public Roads:

County	Date 1927	Cu.Yd.	Price per Cu.Yd.
Cheboygan, Mich.	Aug. 2	130	$2.50
Lexington, S. C.	Aug. 16	300	2.00
Ontonagon, Mich.	Aug. 12	8,939	.75
Washington, Idaho	Aug. 13	200	2.05
DeKalb, Ala.	Aug. 23	3,000	1.25
Madison, Ala.	Aug. 23	3,278	.80
Limestone, Ala.	Aug. 23	2,624	1.00
Stephens, Ga.	Aug. 25	748	2.00
Luce, Mich.	Aug. 27	25	1.00
Franklin, Ia.	Sept. 2	999	2.95
Rutherford, Tenn.	Sept. 16	14,840	1.40

Cost of Gravel Surfacing

Prices given in the accompanying table were compiled from data furnished by the Bureau of Public Roads. The average distance over which materials were hauled to the job was 3.9 mi. Common laborers were paid an average rate of 23.9c. per hr.:

County	Date 1927	Thickness in Inches	Sq.Yd.	Price per Sq.Yd.
Attala, Miss.	Aug. 8	8	12,607	$2.80
Ontonagon, Mich.	Aug. 12	8	80,797	.95
Perry and Hall, Ala.	Aug. 15	9	24,000	2.43
DeKalb, Ala.	Aug. 23	9	15,300	.75*
Madison, Ala.	Aug. 23	9	31,000	.58
Limestone, Ala.	Aug. 23	9	36,192	.85
Luce, Mich.	Aug. 27	8	54,048	.58
Grenada, Miss.	Oct. 14	8	99,900	.33

*Chert.

Construction Cost of Dwelling Houses per Family

The average expenditure in erecting a one-family dwelling in 257 cities of identical population, was $3,972 in 1921, according to the Bureau of Labor Statistics. By 1926, the Bureau states, this average expenditure had risen 19 per cent, to $4,725. The report of the Bureau continues as follows: "The average cost, per family, of apartment houses was only 1.9 per cent higher in 1926 than in 1921. In 1921 the average cost, per family accommodated, of apartment houses was $4,019. A peak of $4,418 was reached in 1924. The 1926 cost was $4,095 per family.

"The costs shown were compiled from estimates given by the prospective builder when filing his application for a permit to build. There is a great difference in the average costs in the different cities. These costs may be over or under-estimated—probably more often under-estimated. They may be more under-estimated in one city than in another. Also, one city may erect houses of a generally higher quality than another. The costs shown apply to the building only; the land is not included.

"In comparing fourteen cities having a population of 500,000 or over, the lowest average cost for one-family dwellings was shown in St. Louis, where the cost per family for all new one-family dwellings built during the first half of 1927, was only $3,540. This contrasts with $6,440 in Chicago. While Chicago showed the highest expenditure per dwelling, for one-family dwellings, of any city taken, as a whole, it was surpassed by three boroughs of New York City. The average cost of one-family dwellings in New York (all boroughs) was $6,184. Washington and Baltimore are but 40 mi. apart, yet the average expenditure for the one-family dwellings built in Baltimore in the first half of 1927 was $3,942, while the average expenditure for those built in Washington during the same period was $6,337. The average expenditure for the 34,735 one-family dwellings for which permits were issued was $5,306.

"The cost per family of two-family dwellings in the first half of 1927 ranged from $3,078 in Buffalo, to $7,125 in the Borough of Manhattan. There were 18,416 families planned for, in two-family dwellings in these fourteen cities, and the average cost per family of these dwellings was $4,793.

"The cost per family for dwelling accommodations in apartment houses in the same period reached the high level of $7,464 in the Borough of Manhattan. The next most expensive unit-cost in this class of structure was in Chicago, where 17,690 families were accommodated at a cost of $5,253 per family. The lowest per-family cost for multi-family dwellings was in Los Angeles, where only $2,143 was spent per family provided for. In the fourteen cities having a population of 500,000 or over, 79,324 families were provided for, in apartment houses. The average cost of these multi-family dwellings, per family accommodated, was $4,185.

"All classes of dwellings, in these cities, provided for 132,475 families during the first six months of 1927. The amount expended per family was $4,563. There were 4,312 families housed, during the period mentioned, on Manhattan Island, and it cost $7,478 per family to house them. The next most expensive housing was provided in Pittsburgh, where 1,425 families were provided with dwelling places at a cost of $5,808 per family. It cost only $2,991 per family to house the 2,709 families provided for in St. Louis, but it cost $4,962 per family to house the 2,583 families accommodated in Washington. In New York (all boroughs) 59,203 families were provided with residences in new buildings at a cost of $4,723 per family."

Industrial Buildings 23 Per Cent Under 1926 Value

Contracts awarded on industrial buildings, at a minimum value of $40,000, for the entire country, amounted to $205,602,000 for the first ten months of this year, according to *Engineering News-Record* statistics. This represents a decline of 23 per cent compared with the total for the corresponding period in 1926. The average contract price this year is $177,000 as against $217,000 last year. Attention is directed to the gain in both number and value of the following classes, as shown in the accompanying table: Food products, automotive, steel mills, refrigeration and cold storage, warehouses, and unclassified factories.

Number and Value of Industrial Building Contracts in First Ten Months of 1926 and 1927

Millions of Dollars (000 omitted)

	1927	1926
Public Utilities		
Value	$33,420	$85,808
Number of contracts	94	81
Chemical Process		
Value	15,513	16,474
Number of contracts	81	86
Food products		
Value	19,759	17,783
Number of contracts	140	135
Automotive		
Value	26,724	25,179
Number of contracts	174	163
Machinery and equipment		
Value	18,151	39,725
Number of contracts	142	285
Textiles and clothing		
Value	13,472	11,620
Number of contracts	76	101
Printing and binding		
Value	3,841	6,377
Number of contracts	34	39
Steel mills		
Value	10,471	5,180
Number of contracts	16	14
Cement and quarry products		
Value	5,752	18,027
Number of contracts	15	26
Foundries		
Value	1,633	2,837
Number of contracts	12	39
Refrigeration and cold storage		
Value	5,538	4,817
Number of contracts	43	33
Lumber and woodworking		
Value	2,012	6,674
Number of contracts	18	43
Warehouses		
Value	10,125	9,626
Number of contracts	60	36
Unclassified		
Value	39,200	15,518
Number or contracts	252	139
TOTAL		
Value	$205,602	$265,645
Number of contracts	1,157	1,220

This Week's Contracts—With Comparisons

Minimum costs observed are: $15,000 for water-works and excavation, drainage, irrigation, levee, river and harbor projects; $25,000 for other public works; $40,000 for industrial and $150,000 for commercial, educational, institutional, religious and other buildings.

Week ended	Public Work	Private Work	Total U. S.
November 24, 1927.	$16,500,000	$32,715,000	$49,215,000
November 17, 1927.	20,239,000	28,514,000	48,753,000
November 25, 1926.	13,986,000	19,147,000	33,133,000
Jan. 1 to date			
1927	1,151,715,000	1,724,207,000	2,875,922,000
1926	994,268,000	1,627,915,000	2,622,183,000

E.N.-R. Index Numbers

On November 1, 1927

COST	VOLUME
201.98	269
Last Year 210.80	Last Year 244

The Index Numbers are published in detail and with charts in the first issue of each month. The Cost Index is given in full from 1903 through 1926, with a thorough explanation of its method of computation, and a graphic comparison with many other index numbers, in the 48-page pamphlet entitled Engineering News-Record Construction Costs.

Weekly Construction Market

	New York	Atlanta	Dallas	Chicago	Minneapolis	Denver	San Francisco	Seattle	Montreal
Steel Products									
Structural shapes, per 100 lb....	$3.34	$3.75	$4.00	$3.10	$3.35	$3.87½	$3.00	$3.00	$4.00
Structural rivets, per 100 lb....	5.00	4.00	4.75	3.60	3.85	4.64	5.50	5.25	5.50
Reinforcing bars, per 100 lb....	3.24	2.99	2.75	2.50	2.87½	3.77½	2.95	3.00	3.57
Steel pipe, black, 2½ to 6 in., lap weld, discount from list.....	48%	40%	54%	51%	48%	41%	42@53.8%	48%	.....
Cast-iron pipe, 6 in. and over, per net ton.....	40.60	34.50	52.00	36.20	40.50	52.00	39.00	53.00	41.00
Concreting Material									
Cement, without bags, per bbl. .	2.35†	2.45	2.05	2.05	2.22	2.85	2.51	2.65	1.41
Gravel, ¾ in., per cu.yd.....	1.75	2.20*	2.38	2.00	1.25*	1.90	1.80	1.25	1.90*
Sand, per cu.yd.	1.00	1.75	2.00	2.00	1.25†	1.00	1.40	1.25	1.35*
Crushed stone, ¾ in., per cu.yd...	1.85	2.50*	2.83	2.00	1.25*	2.50	1.70	2.50	2.00*†
Miscellaneous									
Fir, 3x12 to 12x12, 20 ft. and under, per M.ft. b.m.	.....	.....	.....	39.50(S4S)	36.75 @38.75	34.25	27.00	24.00	55.00†
Pine, 3x12 to 12x12, 20 ft. and under, per M.ft. b.m.....	60@61†	34.00	56.00†	.....	.....	.....	.....	.....	.....
Lime, finishing, hydrated, ton...	19.45	21.50	19.00	20.00†	25.50	24.00	27.50	24.00	21.00
Lime, common, lump, per bbl ..	2.35@2.50‡	1.25	1.82	1.50†	1.70	2.70‡	1.70	2.80‡	10.00*
Common brick, per M	16.00@18.00†	11.50	13.60	12.00†	13.75†	8@12	14.00	14.00	20.25
Hollow building tile, 4x12x12, per block.....	Not used	.068†	.103	.....	.072	.085	.....	.10	.10
Hollow partition tile, 4x12x12, per block.....	.0966	.068†	.103	.076†	.072	.085	.108	.09	.08
Linseed oil, raw, 5 bbl. lots, per 7½-lb. gal.....	.79½	+ 84	.85	.83	+ .87½	.88	.84	.98	.93
Common Labor									
Common labor, union, per hour.	.90½	.30	.....	.90	.....	.....	.50@.60	.70	.....
Common labor, non-union, hour.	.....	.25	.30@.50	.82½	.45@.60	.31¼@.50	....	.62½	.30@.35

*Ton. †Delivered to job. ‡280-lb. net. +Advance. —Decline.

AVERAGE prices paid Oct. 1, 1927, by contractors for building materials delivered on the job, as reported to the Department of Commerce, are as follows:

Common brick, average of prices in fifty-one U. S. cities, per M, $16.73.

Portland cement, without charge for the four bags, fifty-five cities, per bbl., $2.85.

Yellow pine, No. 1, 2x4-in. by 16 ft., S1S1E, thirty-three cities, per M ft., $46.27.

Douglas fir, No. 1, 2x4-in. by 16 ft., S1S1E, twenty-nine cities, per M ft., $43.53.

North Carolina pine, No. 1, 2x4-in. by 16 ft., S1S1E, seventeen cities, per M ft., $44.32.

Common boards, No. 1, 1x6-in., S1S1E, forty cities, per M ft., $42.28.

Yellow pine flooring, edge grain, "C," 1x4-in., 10 to 16 ft., twenty-three cities, per M ft., $79.87.

Douglas fir "V" grain, No. 2, 1x4-in., 10 to 16 ft., twenty-four cities, per M ft., $71.67.

Red cedar shingles, extra clear, 16-in., 5 to 2, forty-three cities, per 100 sq.ft., $6.13.

Cypress shingles, extra clear, 16-in., 5 to 2, nine cities, per 100 sq.ft., $6.95.

Composition shingles, crushed slate surfaced, forty cities, per 100 sq.ft., $6.70.

Gypsum plaster board, ⅜-in., twenty-five cities, per M sq.ft., $28.25.

Lime, hydrated, fifty-one cities, per ton, $20.16.

Building sand, forty-nine cities, per cu.yd., $2.17.

Crushed stone, ¾-in., forty-five cities, per ton, $2.69.

Wire nails, forty-six cities, per keg, $3.65.

Windowglass, single A, 10x12-in., thirty-six cities, per 50 sq.ft., $4.22.

Hollow tile, 8x12x12-in., forty-seven cities, per block, $0.196.

Cast-iron soil pipe, 4-in., 13 lb. per ft., thirty-one cities, per ton, $69.84.

Steel pipe, 1-in., galvanized, forty-one cities, per 100 ft., $10.75.

Reinforcing bars, ¾-in., square, forty cities, per 100 lb., $3.42.

Structural steel, fabricated, 6-in., I beams, forty cities, per 100 lb., $4.11.

White lead, dry, forty-four cities, per 100 lb., $13.73.

Zinc oxide, American process, lead free, twenty-two cities, per 100 lb., $15.66.

Gypsum plaster, neat, fifty-two cities, per ton, $17.84.

Linseed oil, raw, in barrels, forty-one cities, per gal., $0.992.

Roofing slate, No. 1, ribbon, twenty cities, per 100 sq.ft., $13.54.

Tar paper roofing, 2-ply, 75 lb. per roll of 100 sq.ft., thirty-two cities, $2.75.

Rosin sized sheathing, 3-ply, 30 lb. per 500 sq.ft., forty-four cities, $1.31.